PUBLIC WORKS

CITY COUNTY STATE

SEPTEMBER, 1928

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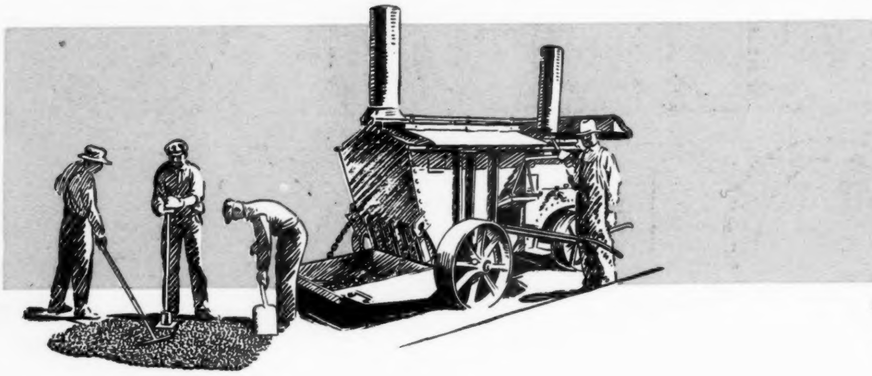

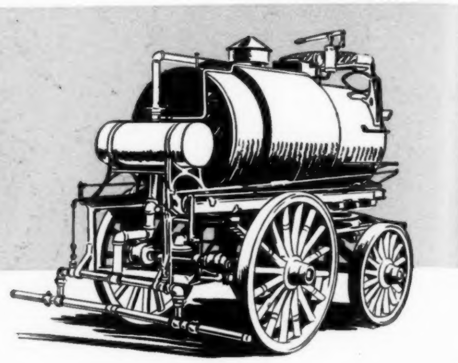

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"MOST MILES FOR YOUR ROAD DOLLARS"

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SEPTEMBER, 1928

PUBLIC WORKS.

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 59 September, 1928 No. 9

Springfield's New Water Supply Developments

Highest earth dam in the world, pressure tunnel and power plant units are included in plan to augment supply. Largest welded pipe line in the East carries water six miles to city, crossing Connecticut River

Additional water supply developments now under way at Springfield, Mass., are of much interest, from standpoints of both design and construction. Included in the work is the construction of the longest welded pipe line in the east, a crossing under the Connecticut river, 7,000 feet of pressure tunnel and the highest earth dam ever constructed. The general layout of the work is shown in Fig. 1.

Present supply. The present supply is drawn from Little River. The principal storage reservoir is the Borden Brook reservoir, located on a tributary of the Little River. It has a capacity of 2,500 million gallons. Water from it flows down Borden brook, and along Little river, past the proposed new Cobble Mountain dam site, and from the diversion dam below the Cobble Mountain dam, is carried through a 68-inch by 75-inch tunnel to the filters. These are of the slow sand type, with an area of 6.25 acres, of which 3.25 acres were built in 1924. The construction of the additional filters was the first step toward meeting the demand for the increased water supply.

From the filter plant, the water passes through five miles of 42-inch Lock-Bar steel pipe to the Provin Mountain reservoir, which has a capacity of about 17 million gallons, or a little more than an average day's consumption. The line from Provin Mountain reservoir to the city is a 42-inch Lock-Bar main. Its capacity is about 28 million gallons per day; but the consumption (which averages only 14 to 15 millions gallon daily) reaches a peak for short periods of about 30 million gallons per day, causing a lack of pressure and even water shortage.

To overcome this, construction was started last fall on an additional pipe line from Provin Mountain reservoir, to and across the Connecticut river, and thence to the city, and the construction work on this is now about 60 per cent. complete. The line is of welded steel, 32,740 feet long, of which 16,140 feet is 54-inch, and 16,600 feet, 48-inch. The Connecticut river crossing is made with two 36-inch lines and the connection thence to the city distribution system is through a 1700-foot line of 48-inch pipe. In the six miles from Provin reservoir to the city, the line drops more than 300 feet.

THE PIPE LINE

Design of Pipe.—The 48 and 54-inch pipe is made in 30-foot lengths from two 30-foot plates which are bent into half cylinders and automatically arc welded together. To facilitate joining sections in the field, the plates are sheared so that the pipe diameter increases slightly from one end to the other, thereby permitting the small end of one section to fit into the large end of the following section.

Steel for the plates must meet the general requirements for fire-box steel as given in the specifications of A. S. T. M., with the exception that tensile strength limits must be between 52,000 and 62,000

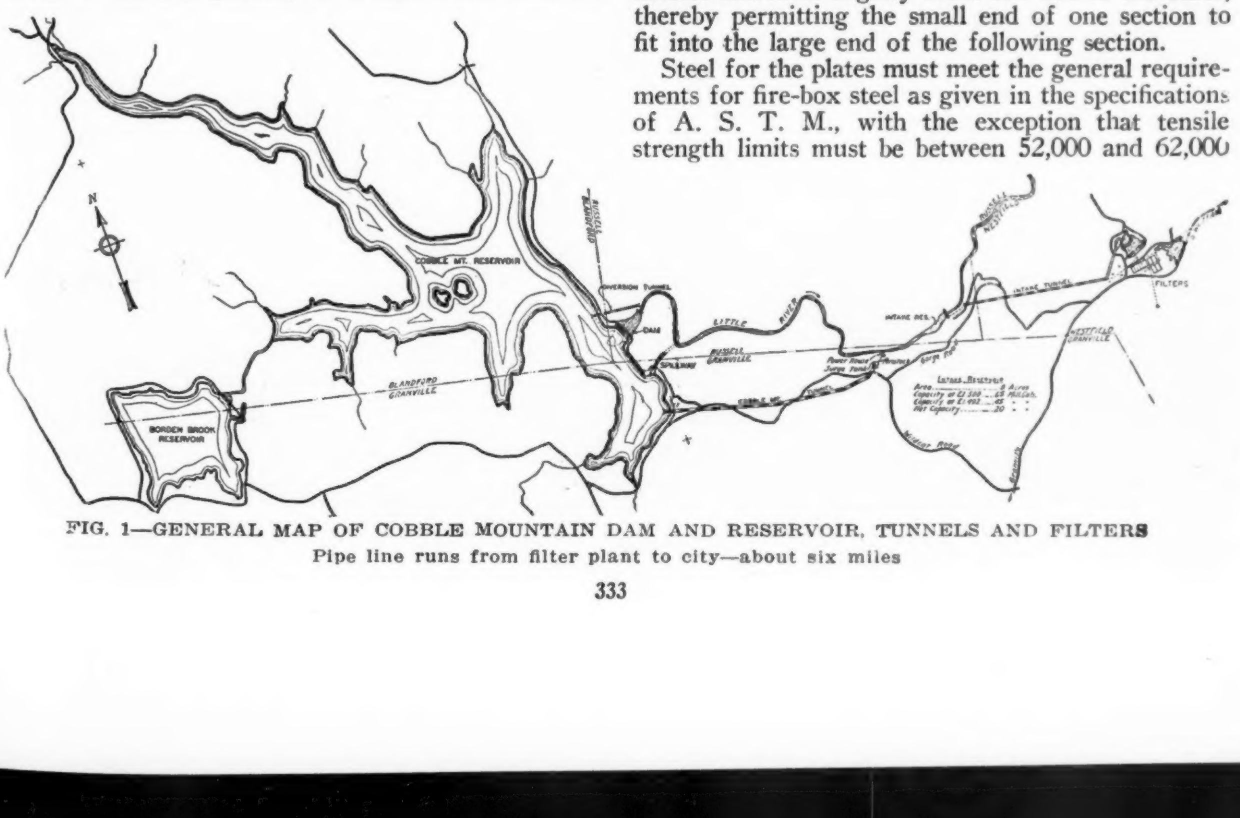


FIG. 1—GENERAL MAP OF COBBLE MOUNTAIN DAM AND RESERVOIR, TUNNELS AND FILTERS
Pipe line runs from filter plant to city—about six miles

pounds per square inch, and some modifications are made in regard to inspection and acceptance. The pipe thickness varies from 5-16 to ½ inch, depending upon the working pressure. Joints are made by riveting, the diameter, pitch and spacing of the rivets and the lap of the plates depending upon the size and working pressure of the pipe.

Fabrication.—The pipe, after shearing, beveling and planing, is tackwelded. It then goes to the welding machine. This is a General Electric welder, which employs two arcs, one following about 8 inches behind the other. The pipe is placed horizontally on a backing-up bar (which passes through the pipe), and is held rigidly in position by means of pneumatic clamps. Under the joint to be made is a copper bar 2 inches wide. The two automatic welding heads, which are used to feed the wire, are mounted on a single motor-driven adjustable speed carriage which moves the head along the pipe at the proper welding speed, usually about 4½ inches per

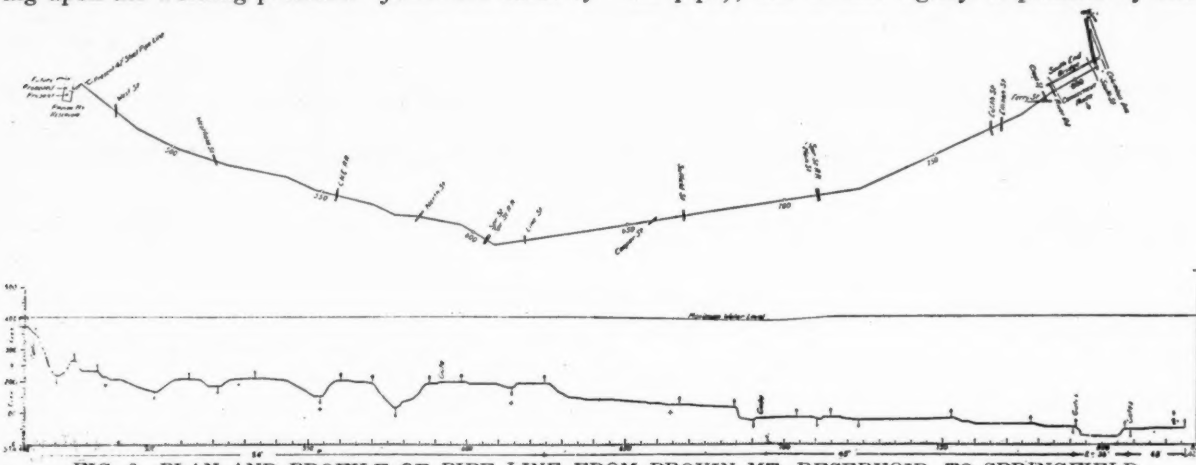


FIG. 2—PLAN AND PROFILE OF PIPE LINE FROM PROVIN MT. RESERVOIR TO SPRINGFIELD

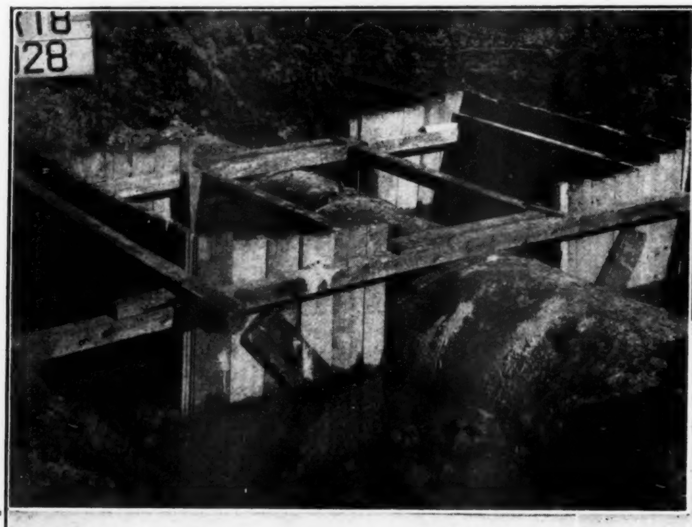


FIG. 3 (UPPER LEFT) TIMBER COFFERDAM AROUND JOINT IN WET GROUND. FIG. 4 (UPPER RIGHT) HAULING PIPE ON SPECIALLY CONSTRUCTED TRAILER. FIG. 5 (LOWER LEFT) NORTHWEST "PULL-SHOVEL" DIGGING TRENCH FOR PIPE. FIG. 6 (LOWER RIGHT) CRAWLER PLACING PIPE IN TRENCH

minute. When the first seam has been completed, the pipe is revolved through half its circumference, and the other seam welded. The 36-inch pipe is made from a single plate and only one seam is required.

at the plant of Walsh's Holyoke Steam Boiler Works, Holyoke, Mass.

Construction.—Much of the pipe line, the plan and profile of which is shown in Fig. 2, is through sandy soil; but in the upper stretches, clay, stones

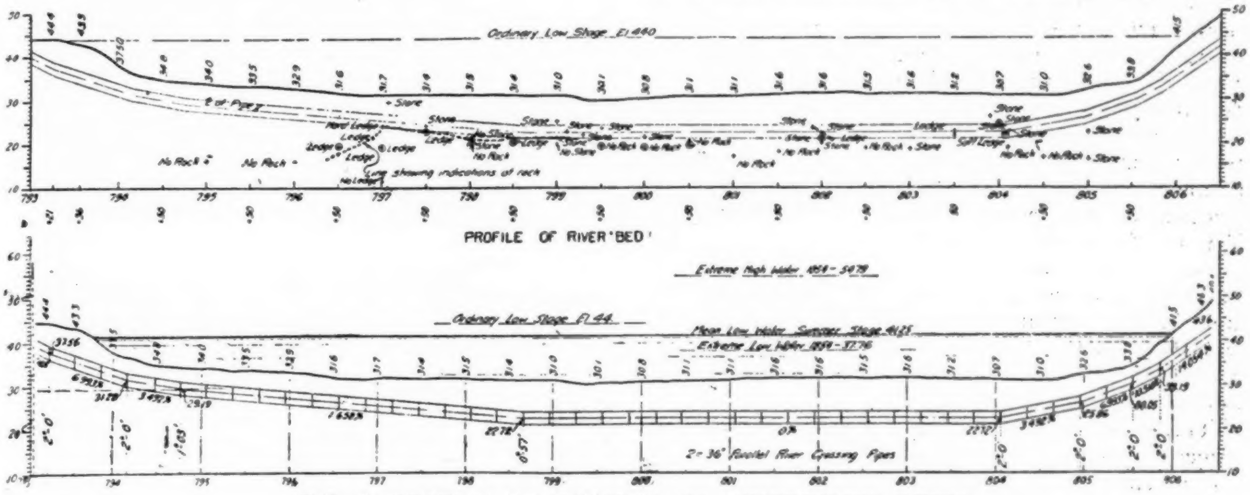


FIG. 7—PROFILE OF CROSSING OF CONNECTICUT RIVER

and rock were encountered. All trenching, so far, has been done by a crawler-mounted Northwest Pull-shovel, equipped with a ⅞-yard bucket, as shown in Fig. 5. This equipment has worked well on all formations, and has averaged about 200 feet of trench daily, including all delays and lost time;

Each pipe section, after welding, is inspected; spots that need further work are hand welded and joints smoothed down by grinders. The pipe is then tested under hydrostatic pressure, cleaned and dipped vertically in coal tar pitch at a temperature of 310° F. The fabrication of the pipe is being done

FIG. 8 (UPPER LEFT) SECTIONAL BARGE FOR DREDGING. FIG. 9 (UPPER RIGHT) JACKS FORCING CUTTING HEAD AND SHIELD UNDER RAILROAD TRACKS. FIG. 10 (LOWER LEFT) JUNCTION AND GATE CHAMBER, EAST SIDE OF RIVER. FIG. 11 (LOWER RIGHT) EXCAVATION FOR EAST GATE CHAMBER BRACED WITH STEEL SHEET PILING, FOUNDATION PILES BEING DRIVEN

on good days it has handled as much as 1,200 yards of material and trenched from 300 to 330 feet. The pipe normally has 3½ feet of cover, and under average conditions there are about 4 yards of excavation per running foot.

Following closely behind the shovel is a Northwest crane mounted on crawlers, and equipped with a special boom (shown in Fig. 6) for handling the pipe. The pipe was hauled to distributing points from the rail unloading points by means of a special truck and trailer arrangement which carried two sections of pipe, as shown in Fig. 4. From the distributing points, the pipe was moved to the final locations by a Cleveland tractor pulling a stone boat fitted with a cradle designed to hold one section of pipe.

The placing of the pipe keeps pace with the trenching. As soon as the pipe is placed, the joints are bolted to hold the section to line and grade, and enough backfill is placed to hold the pipe against flotation or other disturbance.

A Universal crane has proven very useful for special excavation, for trenching for culverts, for placing back filling, and doing other work. Other equipment on this work included Ingersoll-Rand air compressors and drills, Evinrude, Homelite, Barnes, C. H. & E. and Humdinger pumps and a Caterpillar tractor with a LaPlante-Choate Bulldozer.

In the wet sections of the trench, timber cofferdams are placed around the joints, as shown in Fig. 3, preparatory to dewatering for riveting the joints. Following the riveting and calking, the line is tested for leakage at a pressure 100 pounds in excess of the actual service pressure. Several riveting crews are at work. Equipment includes Ingersoll-Rand, Sullivan and Chicago air compressors, Ingersoll-Rand hammers and reamers and C. H. & E., Carter, and Lawrence Vortex pumps.

At the reservoir end, the new line passes very closely to the old line. The formation here is rock, and exceedingly careful blasting and handling of excavation has been necessary to prevent damage to existing structures. This has been accomplished by using small and carefully placed charges.

The contract for this work was let to Daniel O'Connell's Sons, Inc., Holyoke, Mass., for $532,494.

RIVER CROSSING

The pipe line is carried across the river by two 36-inch pipes, spaced 30 feet apart and located in trenches about ten feet below the river bottom. Specifications called for piling supports at 30-foot intervals, but rock was found so close to the trench bottom that this was not always possible, and the pipe line was then placed in concrete cradles. Piling was driven at the ends, and these sections of the line were also protected with concrete. The river profile is shown in Fig. 7.

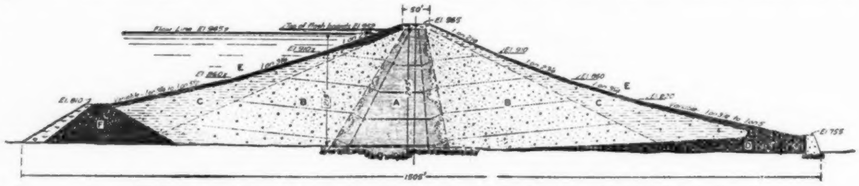


FIG. 13—ACTUAL DEVELOPED SECTION OF DAM
A—Core—Clay puddle deposited under central pool. Effective size approximately 0.01 mm. B—Shoulders—Sand, gravel, rock and boulders, deposited from running water on slopes and fully consolidated. C—Outsde Dumps—Where all the material is first deposited and from which most of it is sluiced but some remains not fully consolidated. D—Lower Wedge of Rock Fill—To be deposited dry before sluicing starts. E—Rock Fill on Face—Broken Mica Schist or boulders. F—Rock Coffer Dam, Previously built.

From the Springfield end of the crossing, a 48-inch line 1,630 feet long ties the new conduit to the city distribution system.

A special sectional barge was employed for dredging, as shown in Fig. 8, using Williams clamshell 1¼-yard and Hayward orange peel buckets. The actual river line is about 1,200 feet long, and the entire section between gate chambers under this contract about 1,800 feet. It is planned to rivet the pipe into 300-foot sections with flanged ends and float the sections to place by means of pontoons. They will then be sunk into the trench dredged for them and the sections bolted by divers, using double lead gaskets between the flangles. The elevation of the river surface at ordinary low stage is about 44 feet, and the river bed varies from 30.7 to 31.6 in midstream, while the center section of the pipe

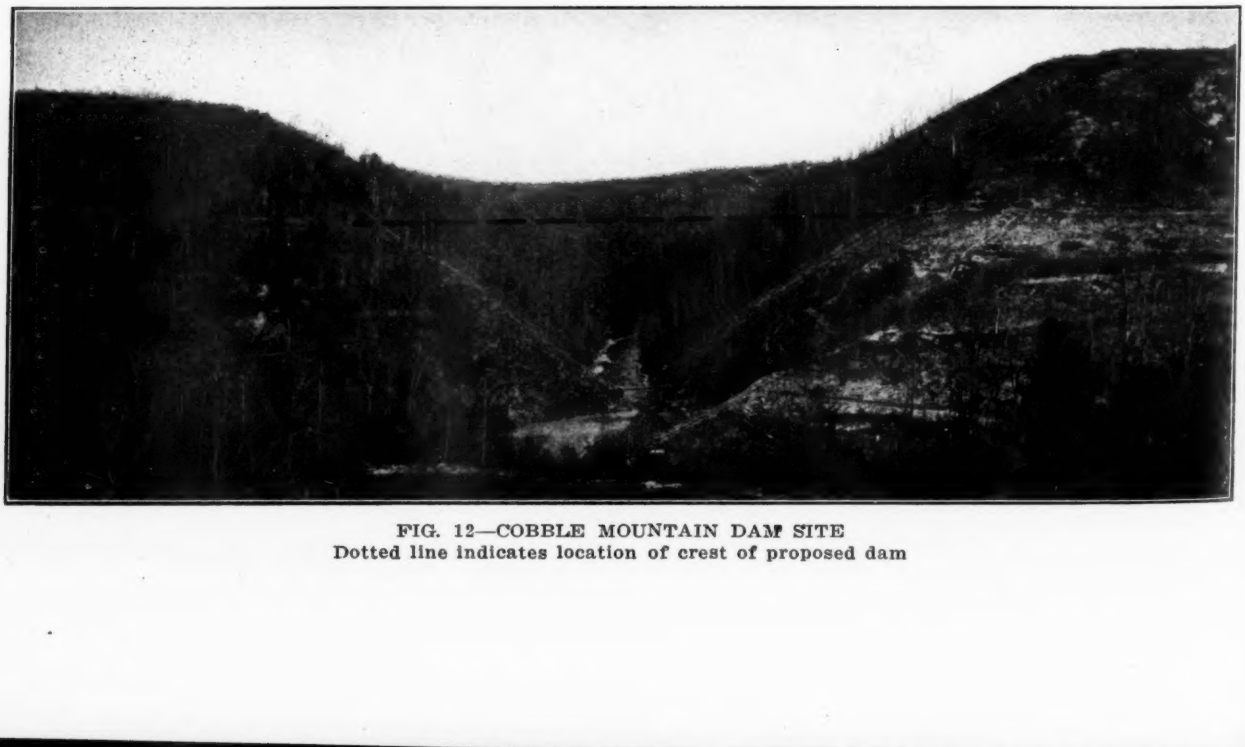


FIG. 12—COBBLE MOUNTAIN DAM SITE
Dotted line indicates location of crest of proposed dam

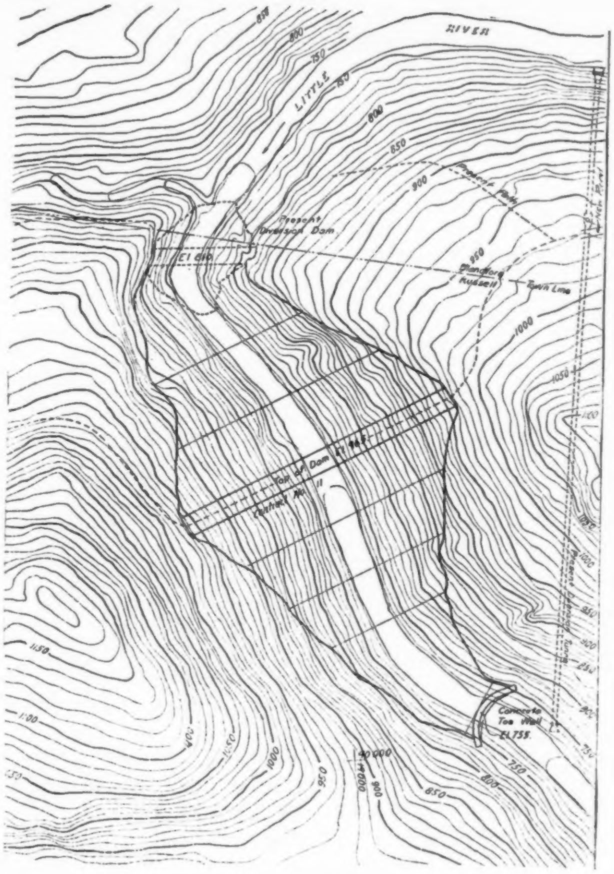


FIG. 14—LAYOUT OF DAM AND DIVERSION TUNNEL

line is at elevation 22.72.

These lines when completed will be tested at 150 pounds and the leakage from both lines must not exceed 300 gallons per hour.

After emerging from the river, the lines pass under the New York, New Haven and Hartford Railroad tracks. At this point there are five tracks, their elevation is 61 feet, while the pipe line in passing under them rises from 47.30 to 49.90. Instead of the usual method of excavation, a 5-foot steel cutting head and shield was driven under the right-of-way by means of four Watson-Stillman hydraulic jacks, shown in Fig. 9, and the tunnel lined with 5-foot sections of steel casing. Inside this lining the 36-inch pipe will be centered and the remaining space filled with concrete.

Just beyond the tracks is located a gate chamber where the two 36-inch lines are merged into the 48-inch main. Excavation for this chamber, which was carried down to elevation 43.90, was accomplished inside of Lackawanna 38-pound steel sheet piling, driven to a depth of 32 feet (see Fig. 10). In the bottom of the excavation, wood piles were driven on 4-foot centers and a 3-foot concrete floor placed. A McKiernan-Terry 9-B hammer was used on all piling. Fig. 11 shows the excavation ready for pouring concrete. Other equipment used on this section included an Ingersoll-Rand compressor, a Ransom mixer, Ingersoll-Rand reamers and 9-A hammer, and a Chicago Pneumatic Tool Co. 110 hammer, which was used mainly for making up the pipe joints.

This contract was awarded to Merritt, Chapman & Scott Corp., N. Y., for $346,375. C. B. Christianson is superintendent in charge of the work.

COBBLE MOUNTAIN PROJECT

The work to be done on this project includes the construction of a hydraulic fill dam across Little river at Cobble mountain, with spillway and appurtenances, and driving 8,000 feet of pressure tunnel under the mountain to a proposed power house near the present intake reservoir. Little river has already been diverted from the site of the dam by a 1,600-foot tunnel, with a capacity of about 4,000 second feet, and this tunnel will remain open during the construction of the dam, after which a concrete plug with two 42-inch gates will be placed in it.

Cobble Mountain Dam.—This dam will have a height of 245 feet above bed rock and a water level 215 feet above the stream bed. It will be the highest earth dam ever constructed, and will be 1,505 feet thick at the base and 50 feet at the crest, and have

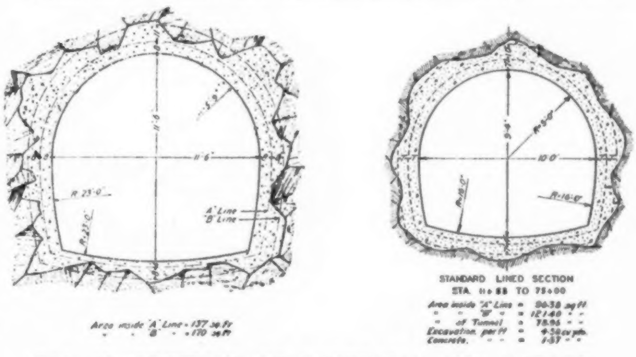


FIG. 15—SECTIONS OF DIVERSION AND OUTLET TUNNELS

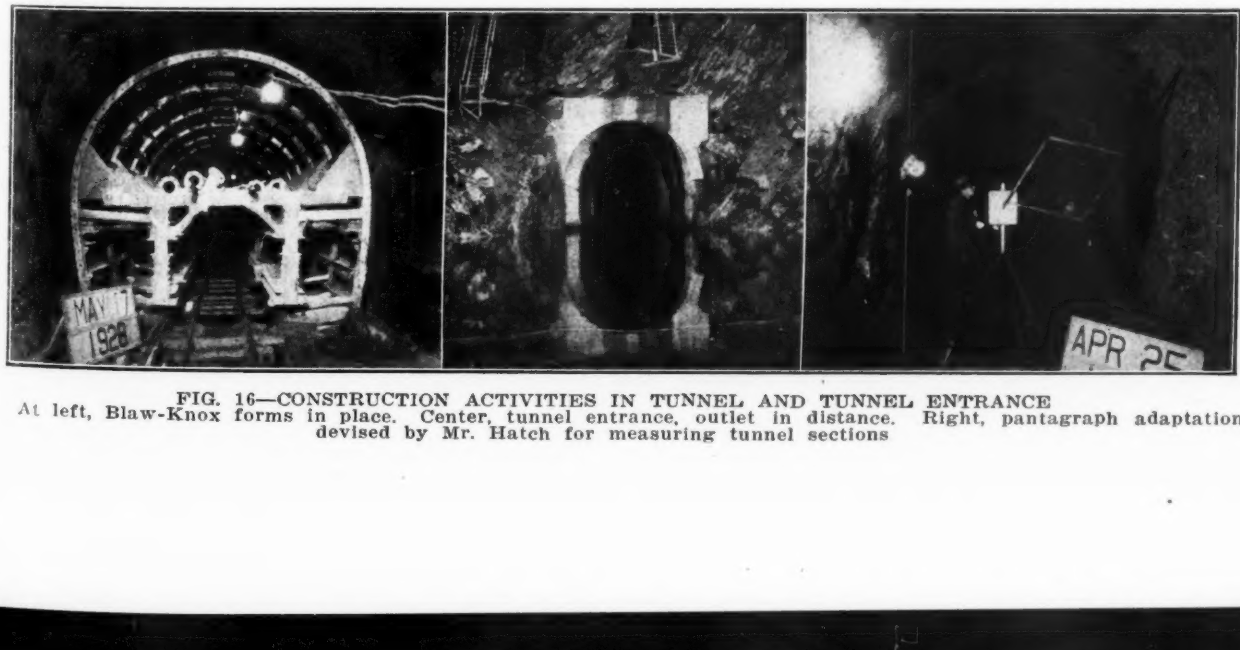


FIG. 16—CONSTRUCTION ACTIVITIES IN TUNNEL AND TUNNEL ENTRANCE
At left, Blaw-Knox forms in place. Center, tunnel entrance, outlet in distance. Right, pantagraph adaptation devised by Mr. Hatch for measuring tunnel sections

a crest width of 700 feet. Its construction will require 1,800,000 cubic yards of material, of which 1,600,000 will be hydraulic fill, 196,000 rock fill, and 4,000 concrete. The dam site is shown in Fig. 12.

The flow line of Cobble mountain reservoir will be at elevation 945; the crest of the dam will be at elevation 965; by means of flash-boards the elevation can be raised 7 feet to 952. The area of the reservoir with normal flow line at 945 will be 1,031 acres, and the storage capacity will be 22.287 billion gallons.

The dam is to be of hydraulic-fill type, with a puddled core flanked by shoulder sections sluiced in place. The general section of the dam is shown in Fig. 13, and the plan and general layout of the work in Fig. 14. The core section will be stripped to bedrock and cut-off walls constructed. A concrete retaining wall will form the lower toe, and a rock-filled section will reach from the cut-off wall at the center of the dam to this toe wall. The upstream slope of the dam varies from 1 on 3¼ to 1 on 5½; the down stream slope ranges from 1 on 2¼ to 1 on 5.

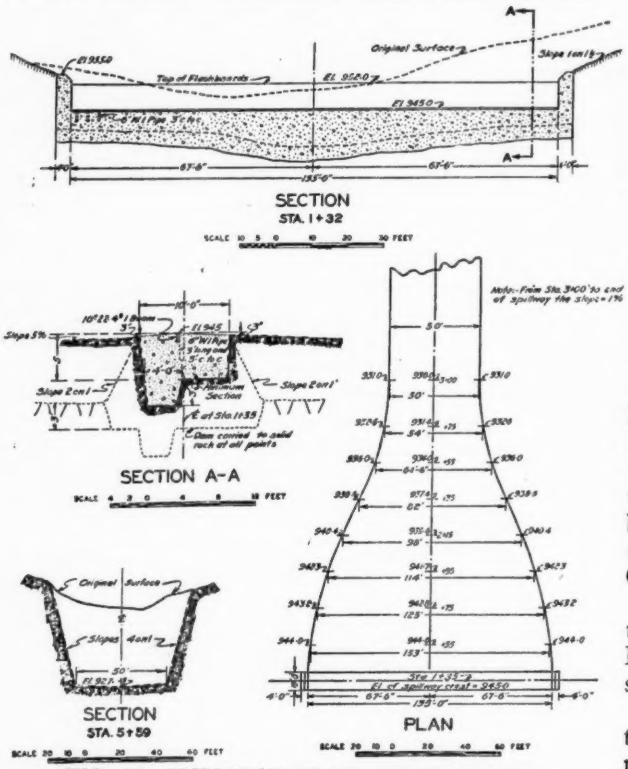


FIG. 17—SPILLWAY PLAN AND SECTIONS

FIG. 18—MODEL OF SPILLWAY

The details of the methods of construction have not yet been decided on, but some of the fine material will be obtained by washing down the side slopes, and the remainder will be secured from nearby sources and hauled or sluiced to the dam. Water from the central pool will be used over and over again; and because Little river is the source of the present Springfield water supply, every effort will be made to prevent pollution from the escape of muddy water into the stream, or from other sources.

The reservoir site will be cleared by cutting all trees and all stumps over 12 inches high; this material and all logs, bridges, buildings, etc., will be burned or removed. Above elevation 915, in addition, all stumps and large roots will be removed to a depth of 6 inches below the surface. In the final clearing two months before the reservoir begins to fill, all high standing grass, weeds and bushes will be removed.

The contract for this work has been awarded to Winston & Co., Kingston, N. Y., at a total cost of $1,437,000.

Diversion Tunnel.—The diversion tunnel, shown in section in Fig. 15, has been constructed by Coleman & Co., Boston. This consisted of 1,700 feet of tunnel of a 11 foot 6 inch by 11 foot 6 inch horseshoe section, located as shown in Fig. 14. Construction methods on this tunnel and the finished entrance are shown in Fig. 16. The muck from the tunnel was removed by narrow-gauge cars hauled by two Plymouth locomotives to the site of the division dam, and used to form the upper toe of Cobble mountain dam.

The contractors are now engaged in the construction of this diversion dam and have on the job two Erie shovels, and a tractor and bulldozer, besides smaller equipment.

Spillway.—A better location for the spillway than that shown in Fig. 1 (south of the dam and Cobble mountain), could hardly have been found. The spillway will be in open cut, 800 feet long and will be unlined except at the crest. The spillway section at the crest will be 135 feet long; it will narrow gradually, as shown in Fig. 17, to a standard width of 50 feet. Discharge will be into Little river, about half a mile below the dam. The maximum capacity of the spillway will be in excess of 20,000 second feet. A model of the spillway built by H. H. Hatch, resident engineer, on a scale of 1 to 50, has been in operation for some time across a small creek and has operated satisfactorily. This is shown in Fig. 18. A 50-foot highway arch bridge will span the spillway.

The future flooding of roads in the reservoir site necessitated the construction of several miles of new roads. In the construction of the Cobble mountain dam, several miles of such roads would be necessary and the city of Springfield therefore decided to go ahead and make available these roads for the contractors, later turning them over to the town to replace the flooded roads. There were built under the direction of Mr. Hatch about 3½ miles of new

road, located, as shown in Fig. 1, along the east side of the reservoir, connecting a state road from Blandford to Woronoco with the dam site. Constructed through exceedingly rough and rocky country, the cost of this road was in excess of $100,000, but th maximum grade is about 2 per cent., the surfaced roadway is 20 feet wide and the alinement is excellent. This road will eventually cross the dam, pass around Cobble mountain, cross the bridge over the spillway and rejoin the county road south of the reservoir.

Tunnel and Power House.—From the reservoir an outlet tunnel of horseshoe section, shown in Fig. 15, will be driven 7,000 feet through the mountain. This will be concrete lined throughout, except for the lower 500 feet, which will be lined with 10-foot steel pipe. From the mouth of the tunnel the water will be carried in a penstock down the mountai side to a power house at the upstream end of the present intake reservoir. The capacity of this tunnel will be 950 second-feet and the available maximum head will be about 440 feet. From the intake reservoir, the water will pass through the present intake tunnel to the filters and thence to the city distribution system. Fig. 19 shows this layout.

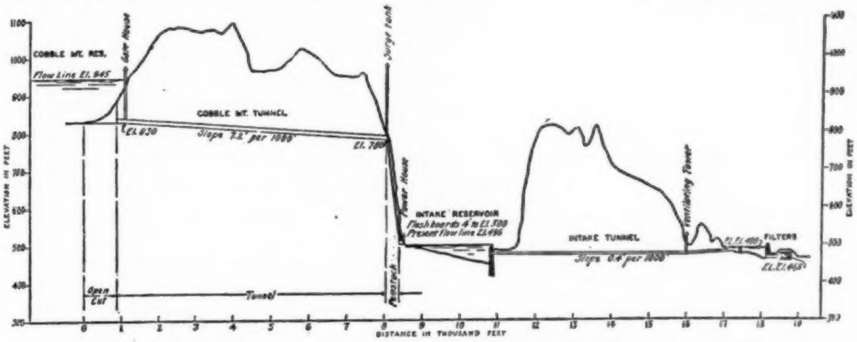


FIG. 19—PROFILE FROM COBBLE MT. RESERVOIR TO FILTERS

The contract for the Cobble mountain intake tunnel has been awarded to the Frazier-Davis Construction Co., of St. Louis, Mo., for $651,000.

GENERAL

The work is being done under the direction of the Board of Water Commissioners of the city of Springfield, Edwin A. Blodgett, George L. Fenn, and Fordis C. Parker. E. E. Lochridge is chief engineer of the Board and J. B. Porter, assistant chief engineer. H. H. Hatch is resident engineer on the Cobble mountain work. Hazen & Whipple, New York, are consulting engineers for the Board.

Dead-End Streets Favored

The Commission on Regional Plan of New York and Its Environs has recently issued a report in which it brings forth arguments in favor of dead-end streets or cul-de-sacs in residential sections as essential for the protection of property values as well as of human life. The report, which was prepared by Lee F. Hanmer, head of the Department of Recreation in the Russell Sage Foundation, who was loaned to the organization for this project, contains the following discussion of this subject:

A satisfactory street plan should include provision for quiet residential streets, in which through traffic is discouraged or deliberately shut off. Notwithstanding this, it has commonly been a policy of city governments to prevent the creation of such streets, which are known as dead-ends or cul-de-sacs. Wherever, owing to some reason of design or neglect, such a street occurs, there is soon an agitation to prolong it as a through street. The fact that in some circumstances cul-de-sacs have proved undesirable does not alter the fact that where they are properly designed and located they have been highly desirable, and are becoming almost essential for safety and for protection of property values in residential areas. To prohibit them generally by means of an official plan is economically unsound—for short non-traffic streets having narrow pavements of light construction are desirable in certain locations and can be made at much less cost than through streets requiring heavy and wide pavements.

A large proportion of the streets do not need to be through streets, if a system of main through streets has been well planned. It is quite common in the suburbs of New York to see houses on sale for long periods when facing on main thoroughfares, and houses occupied as soon as completed when facing side street in the same neighborhood. Non-traffic streets, whether they be indirect side streets or cul-de-sacs, are not only cheaper to make, but the land fronting upon them may be more valuable for residences than that on the main thoroughfares. These non-taffic streets are more private, quieter, cleaner, and generally more desirable. But they must be designed as part of the street system, and must not be the result of the whim of one owner trying to block the traffic from the estate of an adjoining owner.

One extraordinary situation has arisen in streets in crowded centers that remain partly residential, but are partly given up to light industry. In these streets vehicles are using the sidewalks as well as the pavements. Pedestrians having lost the use of the pavements because of the fast moving traffic, are now also being interfered with on the sidewalks by standing vehicles loading and unloading merchandise. The public use of many streets for travel, both by moving vehicles and pedestrians, is seriously impaired by uses that should be confined to private property.

Thus we see that in crowded centers the child has been denied space for play by reason of the absence of courtyards adjacent to the tenements in which they live. The street was their only playground. Later they were driven off the streets because of fast moving traffic. Now the children as well as the moving traffic are having their rights taken away on pavements and sidewalks by standing vehicles and goods in process of shipment. Off-the-street loading and unloading would be a more equitable demand than off-the-street play.

Road Congress in Mexico Week of October Third

Charles Upham, business director of the American Road Builders Association, on August 22, wired from Mexico City, where he was making arrangements for the Second National Road Congress to be held in that city during the week of October 3d, that, according to plans being completed for the congress by the Mexican Highway Commission, President Calles will open the congress and delegates from all Mexican states and representatives from several South American countries will be present.

He reports that fifty manufacturers have concluded arrangements for over 120,000 square feet of space for exhibiting and demonstrating trucks, mixers, pumps, air compressors, asphalt plants, graders, cranes, shovels, rollers, scrapers, crushers and other equipment and road materials.

Reduced railroad rates have been granted and a hotel committee will arrange accommodations. The American Road Builders Association has accepted an invitation to participate in the congress.

A U. S.-Mexican Road

Recently business men of Agua Prieta and the highway commissioners of Cochise county, Arizona, met at the city limits of Agua Prieta and inaugurated work on the road from that city through San Jose to the town of Cananea, Mexico. The road, which will be 45 miles long, will be the first stretch of improved highway to exist in that district of Mexico. It is expected that it will be completed within four to six months and that the cost of construction will approximate $25,000, practically all of which is already in hand; in addition to which the Highway Department of Cochise County is furnishing implements and tools valued at approximately $4,000. About 35 Mexican soldiers are furnishing the labor. The business men of Douglas, Arizona, are assisting in every way possible, as they believe that this road will bring to their city considerable traffic and commerce which now goes to Bisbee, Arizona.

Flush Hydrants In New England

During a fire in Fall River in February, 1928, it was found that the chucks carried on fire apparatus from nearby cities could not be used on the flush hydrants in that city. The National Board of Fire Underwriters investigated the situation and has recently reported upon it.

It found that the threads by which the chucks are connected to the flush hydrants in Boston and in all other cities to the north have practically the same dimensions and are interchangeable one with another. Those in Providence and Fall River are so widely different that they are not interchangeable and cannot be connected up with the fittings of any of the other cities; not only are the thread characteristics widely divergent, but the male thread is on the hydrant barrel rather than on the chuck.

Boston, Fall River, Lowell and Lawrence have adopted the practice of gradually replacing flush hydrants with those of the post type, but at the present rate it will be many years before all of them are replaced.

The use of flush hydrants has been confined principally to New England municipalities where the earliest water systems were installed. Portland, Salem and Dedham are not installing any additional hydrants, and whenever they experience trouble with this type, post hydrants are substituted. The advantages of large quantities of water available from flush hydrants and their being less subject to street damage are more than offset by the disadvantages due to age, trouble in maintenance in keeping covers clear, preventing the freezing of ground water, depreciation of exposed bolts and fittings, increasing difficulty of obtaining replacement parts, and the greater time element involved in their use. This would seem to jusitfy the more rapid replacement of this obsolete type.

In view of the general practice of replacing flush hydrants in all municipalities other than Providence and the existing wide divergency of the chucks and threads of the two kinds most generally in use, the expense necessary to completely standardize the connections is not justified. In Fall River a judicious interposition of post hdrants at an early date appears to be the best solution.

Appellate Division Affirms Typhoid Damage Awards Against Albany, N. Y.

The appellate division of the Supreme Court has unanimously affirmed the action of a supreme court jury which in November, 1926, awarded $2,000 to a minor and $1,000 to his father on the claim that the patient contracted typhoid fever from the drinking water of the city of Albany, in April, 1924. Evidence was submitted to show that for over two weeks during that month polluted water from the bed of the old Erie canal entered cracks in the aqueduct running from the clear water well at the purification plant to the pumping station.

As the decision is particularly important from a public health standpoint, portions of the opinion are here quoted for the benefit of our readers:

" . . . It is claimed that the disease had its inception in unwholesome water furnished by the city, and this condition arose through the negligence of those in charge of the water system in failing to purify the water delivered to consumers; and that the authorities neglected to give warning, although they had notice that dangers existed. . . .

" . . . Beginning on April 7, the water was tested at the state laboratory by and under the supervision of Dr. Wachter, a chemist in the Division of Laboratories and Research of the State Department of Health. These tests were made from the tap which was on the same system as that furnishing water to plaintiff's family. On nearly every day between the 7th and the 23rd of April, colon bacilli were found in increasing numbers, indicating some definite source of pollution not eliminated by the filtration. About this time there was a sudden increase in gastro-intestinal diseases in the city. The officials in charge of the water department had notice of the defective condition of the conduit, the sudden pollution of the water, and of the outbreak of diseases traceable to impure water, but the warnings were ignored. It was a time for prompt and decisive action. There were two possible sources of contamination—one by impure water passing the filters into the well; the other by introduction of polluted water into the conduit. The exercise of vigilance would have led to discovery of the dangerous condition, and reasonable diligence would have provided the remedy. It was possible by greater chlorination before the water went into the clear water well, to eliminate all dangerous bacilli which had passed the filter; and there was a chlorination plant at the Quackenbush street pumping station which would have removed the new pollution occurring in the conduit, but this was not put in use, at least during the first ten days in April. Common prudence would have suggested a notice to citizens that the water had become polluted, and a recommendation that all water intended for human consumption should be boiled. But no preventive measures were taken until an epidemic had broken out. . . .

"To insist that the plaintiff must establish that the infection came from the city water by positive proof, would be to require an impossibility. It is sufficient if it is shown by the best evidence available that the bacilli were introduced into his system by means of the city water, so that the jury may by reasonable inference reach a conclusion to that effect. This

is not speculation, but a process of logical deduction. . . .

". . . . The plaintiff gave proof excluding other sources of infection. The defendant's counsel in argument merely suggests that there are other possible sources, but there was no sufficient proof on its part of their presence or of the probability that such causes intervened to furnish the origin of the plaintiff's disease. The epidemic at this particular time including such a large number of cases, would under the circumstances shown, indicate a common origin. . . ."

Particular attention is called to the next to the last paragraph above, since it is not unusual in cases of this kind for attorneys for the defense to attempt to make the plaintiff furnish positive proof that the infection came from the water, which, as the court justly says, is an impossibility.

"Health News," weekly publication of the New York State Department of Health, for July 30th.

Water Softening at Piqua*

Two years' operation of a plant embodying several unusual features. Aerators, chemical feed devices, mixing tanks, clarifier, settling basins, carbonation chambers, filters, chlorine disinfection. Overtreatment with lime followed by recarbonation

By J. M. Montgomery †

Piqua is located in Miami county on Miami river. Its population in 1920 was 15,044. Previous to June, 1924, the public water supply was obtained from the hydraulic canal which was supplied with water by three small lakes and the Miami and Erie Canal. In June, 1924, a flood occurred which washed out the banks of the hydraulic canal and cut off the water supply of the city. An emergency pumping station was then installed, the pumps taking suction directly from Miami river; the water was chlorinated and pumped to the consumers. Previous to the installation of the filtration plant, the water was not of satisfactory quality and was not generally used in the city for domestic purposes. The existing water purification and softening plant was constructed during 1925 and 1926 following an order from the State Department of Health to provide a satisfactory water supply for the city. It was put into operation in March, 1926.

Source of Supply.—The water supply is ordinarily obtained from Swift Run lake, one of the series of lakes along the hydraulic canal. Water flows by gravity from the lake to the filtration plant. Provision is made for drawing water from Miami river by a low-lift pumping station equipped with two 3 mgd. pumps. The low-lift pumps discharge either to Swift Run lake or to the filtration plant. The water entering the plant is measured by a venturi meter and the amount is controlled by a hydraulic valve operated by a float in the settling basin.

*Paper before Ohio Conference on Water Purification.
†Superintendent of Water Works of Piqua, O.

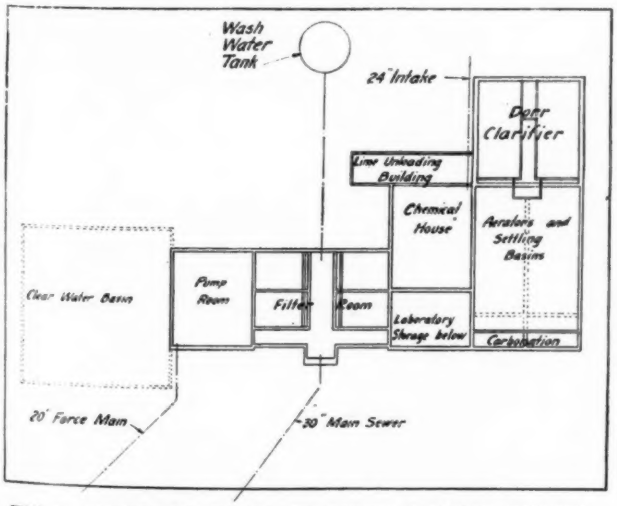


FIG. 1—GENERAL PLAN OF PIQUA WATER PURIFICATION AND SOFTENING PLANT

THE PURIFICATION PLANT.

Aerators.—The water is aerated through a system of forty-eight Sacramento nozzles spaced 9 feet center to center on the roof of the settling basins and carbonation chambers. The water from the aerators passes to the mixing tanks. Piping arrangement permits the aerators to be by-passed.

Chemical Feed Devices.—Alum is fed into the water by means of two 'Gauntt" dry feed machines. Each feeder is equipped with a dissolver and the dissolved alum is piped to the point where the raw water enters the mixing tanks.

The lime is stored in two steel bins. Immediately under these bins are two 2,000 lb. weigh hoppers

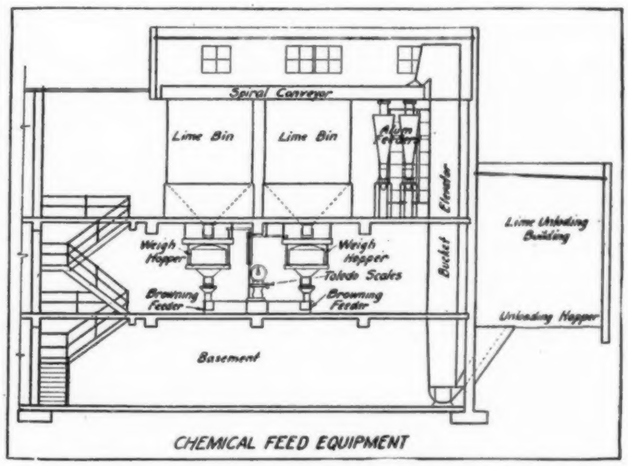


FIG. 2—SECTIONAL VIEW OF CHEMICAL FEED EQUIPMENT

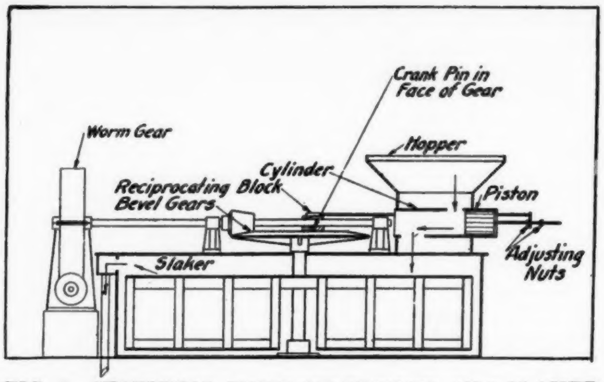


FIG. 3—SECTIONAL VIEW OF FEEDER AND SLAKER

hung on Toledo scales. The weigh hoppers discharge into the lime feeders. The lime is first weighed and then fed into a slaker by means of a "Browning" feeder. This feeder was developed by Oren Browning, the chief operator of the Piqua plant. It consists of a horizontal cylinder and a piston with adjustable stroke. Lime drops into the cylinder through an opening in the top and the piston discharges it into the slaker through an opening in the bottom. From the slaker, the lime solution is piped to the point where the raw water enters the mixing tanks. The feeder is an integral part of the slaker.

The Browning feeder gives a very regular and uniform application of lime. Once set, it requires very little attention except for an occasional cleaning. The scales provide an additional check by showing the operator how much lime has been fed in any given length of time.

Mixing Tanks.—There are two steel, circular, mechanical mixing tanks designed for operation singly, in parallel, or in series. The tanks are 21 feet in diameter with an effective water depth of 22 feet, a total capacity of 114,000 gallons and a detention period of 33 minutes at the rated capacity of the plant—5 mgd.

Mixing is effected by a propeller at the bottom which rotates around a central shaft. Additional mixing is effected by a vertical baffle on the side of the tank. The propellers are rotated so as to produce a velocity of 1.1 feet per second.

Dorr Clarifier.—From the mixing tanks the water passes through a concrete channel to the Dorr clarifier. The clarifier is 50 feet square with an effective depth of 14.9 feet, providing a capacity of 280,000 gallons, a detention period of one hour and 20 minutes, and a velocity of 0.53 foot per minute at the rated capacity of the plant. The water enters the basin through twenty 10-inch holes in the bottom of the inlet trough. Directly under these holes there is a wooden baffle bracketed out from the wall which effectively kills the entrance velocity. The water leaves the clarifier over a weir which extends entirely across the basin. Sludge removal devices are standard Dorr equipment, the sludge being pumped by a Dorrco pump.

Settling Basins.—There are two settling basins arranged for operation in parallel only. Each basin is 24.88'x61.83' in plan with an effective depth of 18.5'. The total capacity of the two basins is 425,000 gallons, which provides a detention period of two hours and a velocity of 0.5 foot per minute at the rated capacity of the plant. The water enters each basin through twelve 6-inch square openings in the bottom of the inlet channel and the outlet to the carbonating chamber is through 6-inch square openings 3 feet below the flow line in the wall separating the settling basin from the carbonation chamber. Each basin drains to a central channel, which slopes to the inlet end, where the sludge is withdrawn through a sluice gate.

Carbonation Chambers.—The carbonating chambers are located adjacent to the settling basins. Each basin is 24.88'x14.75' in plan with an effective depth of 18 feet. The total capacity of the two basins is 99,000 gallons, which provides a detention period of 28 minutes at the rated capacity of the plant. The water flows under a vertical baffle and flows out through an outlet chamber controlled by 2'x8' stop plates. The carbon dioxide distributing system consists of a grid of ¾ inch pipes on the bottom of the tank, which pipes are perforated on the bottom with 3/16 inch holes spaced 12 inches center to center. The carbon dioxide generating equipment consists of a combined coke burner and scrubber, and a compressor driven by a variable-speed motor.

Filters.—There are four filters, each with a rated capacity of 1.25 mgd. Each unit is 18'x24' in plan with a total depth of 8 feet. Each filter is provided with three cast-iron wash-water troughs of adequate capacity for a 24-inch rate of wash. The filtering material consists of 26 inches of sand supported on a 2-inch layer of torpedo sand and five layers of gravel.

The filter underdrains consist of 3-inch laterals spaced on 12-inch centers connected through 4-inch risers to a 2-foot square concrete manifold beneath the filter. Filter equipment consists of Simplex controllers, rate of flow and loss of head gages. All valves are hydraulic valves controlled from operating tables.

Wash Water Facilities.—A wash-water tank having a capacity of 30,000 gallons is located west of the filters. This capacity provides for one five-minute wash of one filter at a rate of 24 inches vertical rise. The wash water tank is filled from the high service mains through an automatic valve.

Clear Well.—Located south of the pump room is the clear well, 75 feet square, with an effective depth of 12 feet. Its capacity is 500,000 gallons, which provides a storage period of 2.4 hours at the rated capacity of the plant. The clear well is covered with a concrete roof on which there is an 18-inch earth fill.

Disinfection.—Chlorine is applied to the filtered water in the main effluent line leading from the filters to the clear well. A pedestal type W and T

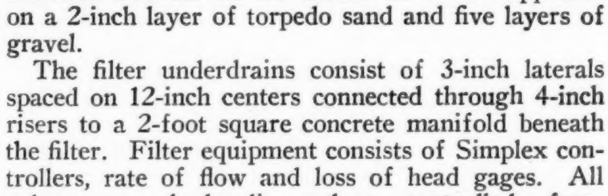


FIG. 4—SECTIONAL VIEW OF CARBONATION PLANT

chlorinator is located at the west end of the filter operating floor.

OPERATING RESULTS.

All of the equipment at the Piqua plant is working out very satisfactorily. The percentage removal of sludge by the Dorr clarifier has been made a routine test. To date, the average has been 97%, with a minimum of 94.5% and a maximum of 99.6%. Very little is left for the settling basins to take out. They have been washed out but twice since the plant was put into operation 18 months ago. In the operation of the clarifier approximately 0.75% of the total water taken into the plant is wasted in removing the sludge.

The filters are being run at a rate of 150,000,000 gallons per acre per day. At this high rate the filters are averaging 28 hours between washings. The amount of wash water required is 1.7% of the total quantity of water taken into the plant.

Table 1 shows an average of the chemical results for September, 1927. The results for the treated water appeared to be low because these samples are heated to 50° C. before analysis in order to complete the chemical reaction and to give a true indication of the chemical treatment.

Table I.—Average Results of Chemical Analyses during September, 1927, for Water before and after Treatment at Piqua Water Softening Plant

	Raw Water	Treated Water*	Settled Water	Carbonated Water	Filtered Water
Total alkalinity...	228	73	88	50	24
Basicity	...	32	26	43	20
Causticity	...	41	58	..	..
Incrustants	32	32	31	31	32
Total hardness....	260	105	119	81	56
Magnesium	25	..	..	..	5

*Sample heated to 50° C. before analysis.

The exceptionally low alkalinities obtained in the filtered water are due a new method of treatment which has been worked out and put into effect. The rest of this paper will be devoted to an explanation of this treatment.

Carbonate hardness can not be reduced to zero by treatment with lime because the calcium carbonate formed by the additional of lime is soluble to the extent of about 17 parts per million. This figure is the ultimate limit toward which the lime softening plant can work.

In actual practice in the past, the limit to which carbonate hardness could be removed was much higher than 17 parts per million. The limited results that could be obtained were due to the presence of magnesium in the raw water and to the formation during the softening reaction of complex magnesium compounds which are soluble in water. These compounds, according to Hoover, have the following formulas:

$$Mg_4\ (OH)_2\ (CO_2)_3$$
$$Mg\ CO_3\ Na\ H\ CO_3\ 4H_2O$$
$$Mg\ CO_3\ Na_2\ CO_3$$

These basic carbonates are most likely to be formed when soda ash is used along with lime in the treatment of the water, but they are also formed when lime alone is used if the raw water contains magnesium carbonate.

A great deal of work has been done and a number of papers have been written on how to lower the limit to which carbonate hardness can be removed by the lime treatment. It is possible to add an excess of lime and in this way precipitate practically all of the magnesium. The excess lime is then neutralized with soda ash leaving free sodium hydroxide in the water. This treatment is both expensive due to the use of soda ash and objectionable due to the free sodium hydroxide. Split treatment, which consists of mixing all of the chemicals required with a part of the water and subsequent mixing with the rest of the water, is helpful but does not greatly lower the point to which the carbonate hardness can be reduced. Compounds of aluminum are also helpful under certain conditions but they are too expensive.

Another method has been made possible by the installation of carbonation equipment in connection with lime-soda water softening plants, namely—overtreatment with lime followed by recarbonation. This treatment has been used at Piqua since the middle of June of this year.

At the time that the carbonation plant at Piqua was first put into operation, considerable difficulty was being experienced in regulating the lime feed. At times the water would be overtreated and at other times undertreated. During this time beginning in August, 1926, a great number of freak results were obtained which were difficult to account for. At times the alkalinity of the filtered water would be as low as 18 parts per million.

A study of the daily analytical sheets showed that these low alkalinities always followed a period of high over-treatment with lime followed by recarbonation to the point where the total alkalinity minus two times the phenolphthalein alkalinity equaled approximately five. The following is a total example:

Total alkalinity (M. O.) 23
Phenol alkalinity (Ph.) 9
$23 - (2x9) = 5$

At that time it was impossible to get these results consistently because of the difficulties with the lime feed.

J. R. Baylis early in 1927 obtained similar results in his laboratory. He overtreated water until he had a caustic alkalinity of 110 parts per million and then recarbonated. The resulting water showed

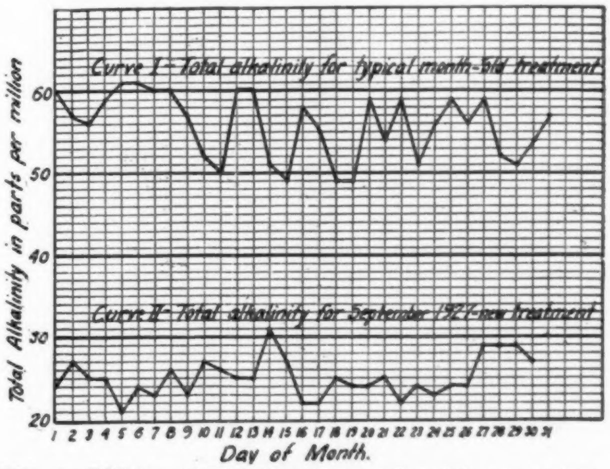


FIG. 5—TOTAL ALKALINITY OF FILTERED WATER COMPARED FOR TYPICAL MONTHS UNDER OLD AND NEW METHODS OF TREATMENT

a carbonate alkalinity of only 30 parts per million.

Mr. Hoover in one of his papers has also mentioned over-treatment with lime followed by carbonation as a method of reducing carbonate hardness.

Early this summer Browning dry feed machines for lime were put into operation at Piqua. These machines gave a very accurate feed and it was then possible to try to duplicate consistently the freak result obtained before. In Fig. 5 will be found curve 1 showing the alkalinity of the filtered water during a typical month under the old treatment. Curve 2 shows the alkalinity of the filtered water during the month of September, 1927, as a result of the new treatment.

It was found that for the Piqua water it was necessary to add lime in excess and to the extent of obtaining 40 parts per million causticity. Any less than this amount gives corresponding higher alkalinities to the filtered water. Any more than this amount is unnecessary. The water is then recarbonated to the point where the total alkalinity minus two times the phenolphthalein alkalinity equals approximately 5. After passing the filters, the water then has a total alkalinity of 20 to 25 parts per million, consisting of 15 to 20 parts per million of normal carbonates and 5 parts per million of bicarbonates.

Very strict regulation of both the lime and the carbon dioxide feed is required to produce these results. The treated water a Piqua had at least 40 parts per million of caustic alkalinity and any slight deviation from the required amount of carbon dioxide will make a great difference in the finished product. The total alkalinity minus two times the phenolphthalein alkalinity must be very close to 5.

The chemistry of this treatment is assumed to be as follows:

Due to the heavy over-treatment with lime, practically all the magnesium is precipitated in the form of flocculent magnesium hydrate. When the magnesium has been precipitated, the chief obstacle in water softening has been removed. The alkalinity due to calcium carbonate is very readily reduced. In the carbonation process, the excess lime or free calcium hydroxide is precipitated as calcium carbonate which is removed by the filters.

Quantitative determinations made every day for a period of 50 days show that there is twice as much suspended matter in the carbonated water as there is in the settled water. Fig. 6 shows graphically the suspended matter in the treated, settled and filtered waters.

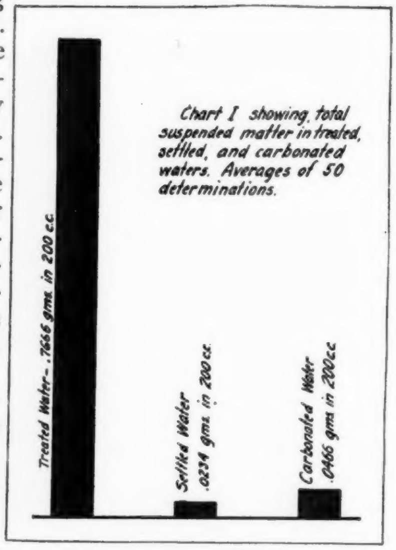


FIG. 6—COMPARISON OF TOTAL SUSPENDED MATTER IN SOFTENED WATER BEFORE AND AFTER CARBONATION, USING NEW METHOD OF TREATMENT

Water treated by this process will, possibly, cause incrustation of the sand in the filters but the filtered water is so close to the theoretical solubility of calsium carbonate that it gives no indication of causing any deposit whatsoever.

Fig. 7 was prepared by Mr. Bayis and shows the relation between hydrogenion concentration, total alkalinity and the incrusting properties of waters. The curve shows that if a water has an alkalinity of 24 it can have a pH of 9.6 and will not cause incrustation. The water at Piqua has an average alkalinity of 24 and a pH of 9.1, therefore it should not form any deposition whatsoever after it has passed the filters.

The extra softening provided by this method of treatment costs but slightly more than the ordinary lime softening process. It has been customary in lime softening plants to carry about 5 parts per million of caustic alkalinity in the treated water. The new treatment requires 35 parts per million in addition to this amount. Thirty-five parts per million of caustic alkalinity is equivalent to 20 parts per million of 100% CaO.

This in turn is equivalent to 150 pounds of 100% lime to remove approximately 30 parts per million of hardness from a million gallons of water. If 100% lime costs $10 per ton, this is a cost of 2.5c. per part per million, per million gallons of water treated. The cost of ordinary lime treatment at Piqua with 100% lime at $10 per ton is 4.0 cents per part per million, per million gallons. The cost of soda ash treatment, with soda ash at $30 per ton, is 12c per part per million, per million gallons.

If this process does cause incrustation of the filter sand, the cost of replacing the sand must be added to the extra cost for lime. The filter sand might be considered as a softening agent. The filters at Pique contain 130 cubic yards of sand. At $5 per yard it would cost $650 to completely replace the sand. If the sand had to be replaced in ten years, the cost would be $65 per year to remove approximately 30 parts per million of hardness. At the present rate of consumption this is equivalent to a cost of 0.36c. per part per million, per million gallons of water treated. The cost of lime (2.5c. per part

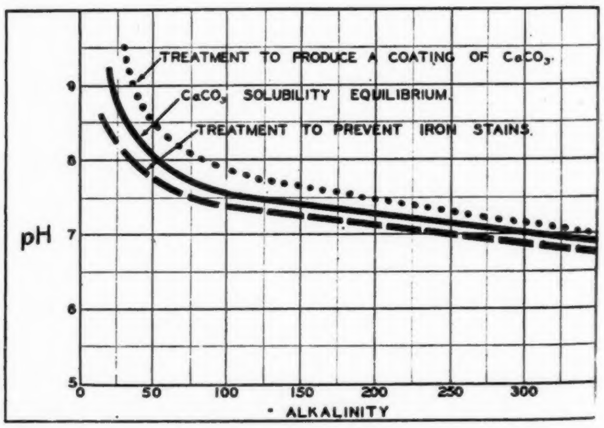


FIG. 7—RELATION OF pH AND ALKALINITY TO THE PROPER TREATMENT OF WATER TO PREVENT CORROSION

per million) plus the cost of sand (0.36c. per part per million) makes 2.86c. per part per million, per million gallons. The additional 30 parts per million of hardness which is removed by this method is removed more cheaply proportionately than the other 170 parts per million of hardness.

The amount of carbon dioxide used is about the same as is used for regular lime treatment. The new treatment uses only enough carbon dioxide to convert the caustic alkalinity to normal carbonate alkalinity and crystalline calcium carbonate. The regular treatment uses the carbon dioxide to convert the caustic and normal carbonate alkalinities to bicarbonate alkalinity. The quantity of carbon dioxide required for each method of treatment is about the same.

The total hardness of the filtered water is averaging about 50 to 55 parts per million without the use of soda ash. Without the new method of treatment the total hardness would be 80 to 85 parts per million. The additional softening is greatly appreciated by the consumer.

In the discussion of this paper J. Q. McQuire of Greenville, Ohio, stated that the well water used in his city had an alkalinity of 350 p. p. m., incrustant 100, magnesium 40, and temperature 12° C. Treatments consist of the application of lime and soda until a causticity of 40 p. p. m. is reached. Carbon dioxide is then applied to the settled water until the total alkalinity minus twice the phenol alkalinity is five. The total alkalinity of the filtered water is about 35 p. p. m. and the incrustants are about 55 p. p. m. The resulting hardness of about 90 p. p. m. is produced at no greater cost than for the former treatment when the hardness of the filtered water averaged about 120 p. p. m. As the pH of the filtered water is 8.4, no difficulty due to incrusting of sand is expected.

D. E. Davis, consulting engineer of Pittsburgh, whose firm designed the Greenville plant, said it had much smaller settling basins than were formerly thought necessary and that they had designed a plant for Fostoria in which only a Dorr clarifier is provided, the water passing from the mixing chamber through the clarifier, then through the recarbonation chamber and thence to the filters. Mr. Hoover said he considered it reasonable to eliminate settling basins entirely if the water is well mixed and passed through a clarifier; but there should be another clarifier or a settling basin in reserve for use when the clarifier needed repairs.

P. D. Waggoner, of Delaware, Ohio, who had been using the Piqua method for three months, had noted a 20 per cent. increase in his filter runs. Most of the precipitate settled out as soon as the water entered the settling basin.

Resurfacing Old Roads in Indiana

Work in 1927 included a rock asphalt top on a bituminous macadam layer, and a so-called top consisting of successive applications of bituminous material and crushed stone

A paper with this title was read before the 14th Annual Road School at Purdue University by A. H. Hinkle, superintendent of maintenance, Indiana State Highway Commission. Mr. Hinkle stated that it is evident that this subject will "be an appropriate subject forever, for the more roads we build, the more old roads we will have each succeeding year and the problem of how to take care of them and with what to resurface them is an important one from the point of view of highway economics." Mr. Hinkle described only two classes of resurfacing, being those which were more or less new in his state during 1927. These included using three-fourths of an inch of rock asphalt on bituminous macadam, and resurfacing old stone and gravel roads with bituminous retread top.

ROCK ASPHALT TOP

The former treatment was given to an old concrete road built some years ago, which, due to defective concrete and insufficient thickness of slab, had broken up badly under traffic. "Before resurfacing, the places that were too defective in the old slab were patched with concrete. The old concrete was given a light surface treatment of liquid asphalt C.B. or asphalt OH_2 and number 4 covering to roughen the surface and thus avoid a slick, hard condition which would permit the macadam stone to slide about under the roller." Three other roads treated in the same way were old macadam roads, which were first levelled and trued up with a water-bound macadam course.

On the roads thus prepared a bituminous macadam layer was constructed 3½ inches thick. Only about ten pounds of covering stone were used per square yard and one and a quarter gallons of tar or asphalt per square yard in two applications. This left the surface of the black base with voids so that the rock asphalt anchored itself well to it. On this base a rock asphalt top was built with a compacted thickness of about three-quarters of an inch. The amount of rock asphalt used was 75 to 80 pounds per square yard.

After the rock asphalt had been broken up it was spread to a thickness of 1⅛ inches and luted to a uniform surface. It was then rolled with a five-ton tandem or a ten-ton three-wheel roller. After the first rolling, the rock asphalt was planed to a level surface with a long-base metal planer which cut the high places and filled the low places with loose material. Additional rock asphalt was fed in front of the planer blades where necessary to provide material to fill up any small depressions in the surface. After going over the surface several times with the planer, it was rolled again and where necessary further planing was done. In all cases the final rolling was done with a ten-ton three-wheel roller.

It was necessary to allow the rock asphalt to stand for a time varying from half a day to a week

before the first planing; the duration of curing depending largely upon the atmospheric temperature. That laid in October normally had to cure 4 or 5 days before it could be planed successfully. If the attempt is made to plane the surface too early, the planer blades will tear up large areas of the surface; whereas if it is delayed too long, the rock asphalt will become so hard that it is very difficult to plane off the high places. With this method of construction it is not difficult to secure a surface which shows no depressions greater than ¼-inch with a 20-foot straight edge, or greater than ⅛-inch with a 4-foot straight edge when laid parallel with the center line of the pavement.

RETREAD TOP

The retread top referred to is described as "a mixture of bituminous material and crushed stone, slag or gravel, made by applying successive applications of the bituminous material to a layer of aggregate spread on the old road to a smooth surface and a uniform crown and grade. The mixture is kept smooth and uniform, by the use of a grader or planer if necessary, until the bituminous material hardens sufficiently to cause the stone to compact under a roller. The aggregate is rolled after each application of bituminous material when the bituminous material is in the proper stage of curing. The surface voids that can not be closed by rolling after the second application of bituminous material are closed by the addition of No. 4 aggregate."

The old road is first trued up by dragging and scraping. It is then covered with 1 inch to 3 inches of No. 2 or No. 3 crushed stone, slag, or gravel, spread directly from trucks but levelled with a road grader and maintainer so that it conforms to the proper crown and grade. This is compacted with a ten-ton three-wheel roller just preceding the first application of bituminous material, except that rolling may be omitted if the aggregate consists of No. 3 stone.

The first coat of bituminous material is then applied and the aggregate rolled once while it is quite soft so as to secure the maximum smoothing effect. As soon as the bituminous material has hardened sufficiently so that the stone will compact well and remain so under rolling, it is thoroughly rolled with a ten-ton roller. This rolling must be extended over several days in order that the aggregate will assume a proper position and remain bonded in place after the rolling is completed. A second application of bituminous material is then made and when it has reached the proper curing stage the road is again rolled. After it has become solid, the voids in the surface are filled uniformly with loose No. 4 covering. No rolling or traffic is permitted on this loose covering before the third application of bituminous material. This third application is covered with additional No. 4 aggregate, after which the surface is thoroughly dragged with a long-base metal blade drag or planer and is again thoroughly rolled. It is always best to be conservative in the amount of bituminous material used, keeping in mind that a little additional material can be added at any time, while if too much is applied it is impossible to remove the excess.

This type of surface should not be built on a road with very little base metal where heavy trucking is part of the traffic. It has merit in surfacing old stone and gravel roads which have a heavy course of metal or roads which carry a heavy automobile traffic only during the summer season. With proper conditions of base and traffic, this type has its chief merit in that smooth-riding, dustless surface can be built at a very low cost compared with many types of pavements. It is cheap in first cost because of the nature of the construction work, which permits dumping and spreading the stone direct from a truck and leveling it with a grader or maintainer before the bituminous material is applied.

New Mexico Tries New Grading Machine

On State Road No. 2 of New Mexico, the Hinkle Highway, the state highway forces under direction of assistant bridge engineer Lee Campbell are trying out a new machine for grading which is com-

THE "TUMBLEBUG" AT WORK

monly called a "Tumblebug." It is an Atlas rotary fresno powered by a Monarch "50" tractor. They report, in the "New Mexico Highway Journal," that it "hauls a load nearly five times as large as does the four-horse drawn fresno of the past and present, does the work with greater speed, and cuts the cost of building heavy cuts and fills to a minimum.

"The machine, powered by a small tractor, manoeuvers around in a manner equal to or of greater flexibility than can a team of horses and at the same time does not know what it is to be tired. Estimates given roughly by Mr. Campbell set the cost of moving a specified amount of dirt by both machine and teams in a ratio of one to five."

Filtration Plants for Two New York Cities

The village of Fredonia, N. Y., has just let a contract for the construction of a filtration plant for the public water supply of the village. The plant is to be of the gravity rapid sand type and is expected to cost about $78,000. The sewage treatment plant for the village, which has been under construction for some time, is practically completed and will be in operation very soon.

The city of Lockport, N. Y., which sometime ago acquired a site for a water filtration plant, has also just let a contract for the construction of a filter plant. This plant which will treat Niagara River water is expected to cost approximately $550,000.

Reaeration of Water by Algae

In an article on the Baltimore sewage treatment plant in the Bulletin of the Maryland State De-

partment of Health, Edward C. Cromwell states that the water of Back river, which receives the final effluent of the plant, has a dissolved oxygen content varying from 80% to 180% saturation during the open season. The super-saturation is due to the prolific growth of large quantities of algae feeding upon dissolved organic matter, so that the algae growth is an important factor in the reaeration of the water receiving the effluent.

The raw sewage has a biochemical oxygen demand of 222 parts per million and the final effluent an average of 29 p.p.m. The trickling filter effluent has a dissolved oxygen content of from 1 to 4 parts per million.

Mount Airy Waterworks

Old plant rebuilt, giving mixing chamber, coagulating basins, rapid sand filters, clear water reservoir, wash water tank and pumping plant

By Preson P. Phillips*

Mount Airy, North Carolina, is located almost at the foot of the Blue Ridge mountains and is often called the "Granite City" because here is located what is said to be the largest open-face granite quarry in the world. The city has grown very rapidly during the past few years and the present population is estimated at 7,500.

In 1903 the Rucker-Witt Tobacco Co. furnished the first public supply to the city, from a deep well drilled near the center of the present city. In 1904, this supply proving inadequate, a well 25 feet deep and 40 feet in diameter was built around a spring just outside the city, the water from which was pumped to a wooden tank erected on a hill at the northern edge of the town. This supply in turn was found to be inadequate and in 1905 a small intake dam was built across Creasy's Branch, which had a watershed area of one-quarter square mile, and the water led to the "town well" already referred to.

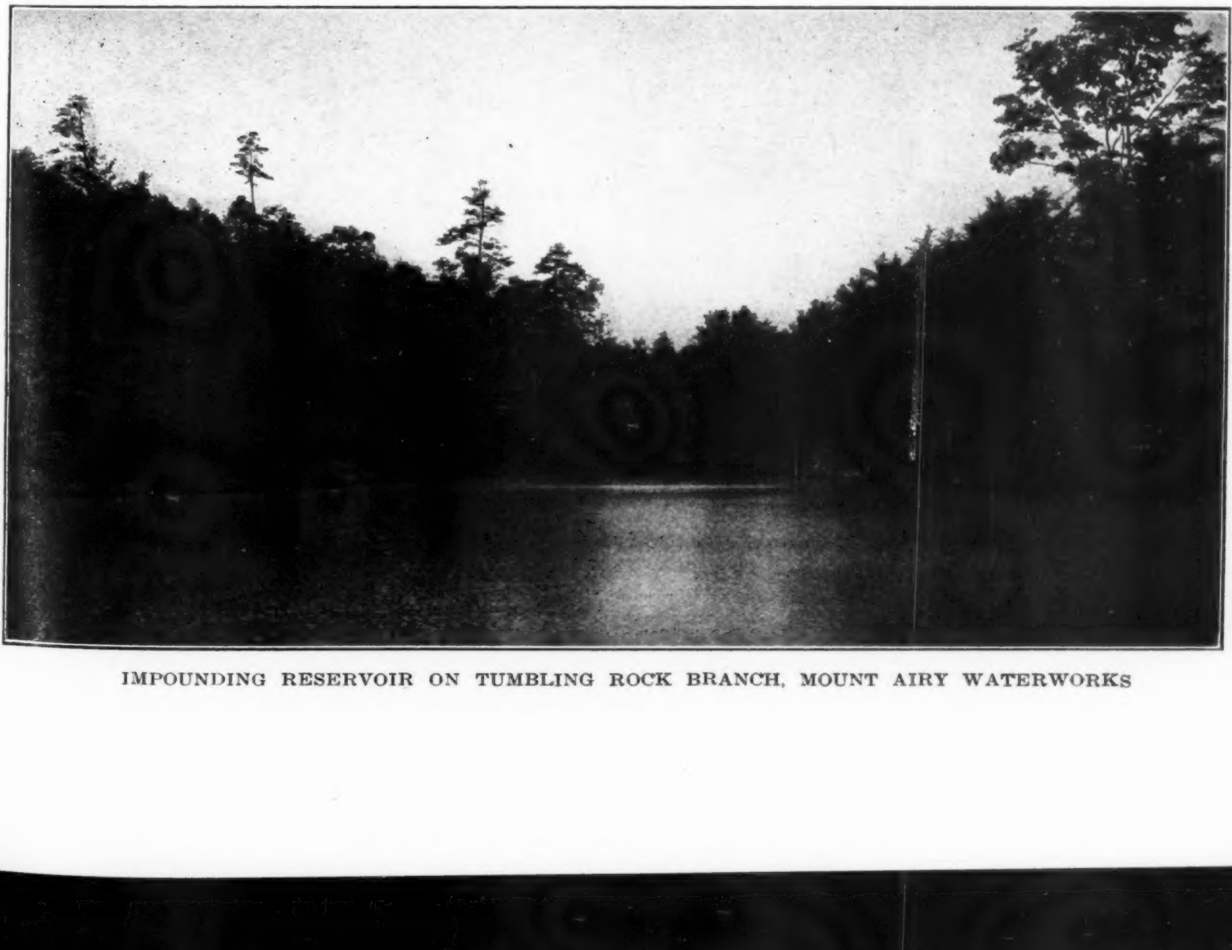
By 1910 the supply was again inadequate and a small intake dam about three feet high was built across Tumbling Rock Branch, which had a watershed area of about 1 square mile, and this water also was led through an 8-inch spiral steel pipe 4,600 feet long to the old well.

In 1913 the first filter plant was built and an elevated steel tank with a capacity of 150,000 gallons replaced the old wooden tank, and the water was treated with sodium hypochlorite. In 1922 a Wallace & Tiernan chlorinator was installed, and in 1924 a large concrete coagulating basin designed to treat 1,000,000 gallons per day was built.

The supply of water again proving inadequate in 1925, a 21-foot earth dam was built just above the old intake on Tumbling Rock Branch, giving a reservoir with a capacity of 10,000,000 gallons, and a new 200,000-gallon elevated steel tank was added to the distribution system. However, the watershed of Tumbling Rock Branch did not warrant an impounding reservoir of this capacity, and its yield was not sufficient for the demands of the town, and the next year it was found necessary to pump raw water from a creek during a dry spell.

Realizing that some radical move was necessary

*Designing Engineer, Gilbert C. White Co., Durham, N. C.



IMPOUNDING RESERVOIR ON TUMBLING ROCK BRANCH, MOUNT AIRY WATERWORKS

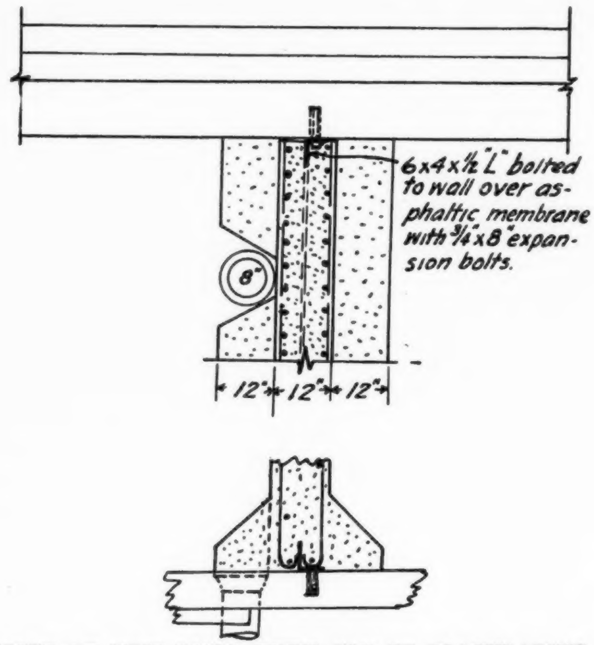
to permanently increase the water supply to the demands for the next few years, the Gilbert C. White Company was asked to report on the supply. These engineers reported on the incapacity of the watershed of Tumbling Rock Branch; also that the filter plant was badly scattered, some parts of it obsolete and others inefficient, the only structure found worth retaining in a new plant being the coagulation basin and the clear water reservoir. They reported that the best source of supply that would guarantee sufficient water for years to come was Lovill's Creek. Above a point about three miles from the city, selected for the intake, the watershed had an area of 22½ square miles and the estimated flow of the creek without storage was about 3,000,000 gallons a day. They recommend the adoption of this supply and the construction of a modern filtration plant of adequate size.

This report was adopted and construction of the new plant began January 1, 1927, and was completed in August.

The point at which the intake was constructed was just above an old dam built for power by a flour mill, which point is considered an ideal site for the construction of an impounding dam in the future, when increased consumption may render it necessary. With the dam, this site will provide the town with more than 4,500,000 gallons of water per day. From this intake the water flows by gravity through three miles of 14-inch cast-iron pipe to the filtration plant, which is located at the site of the old brick well.

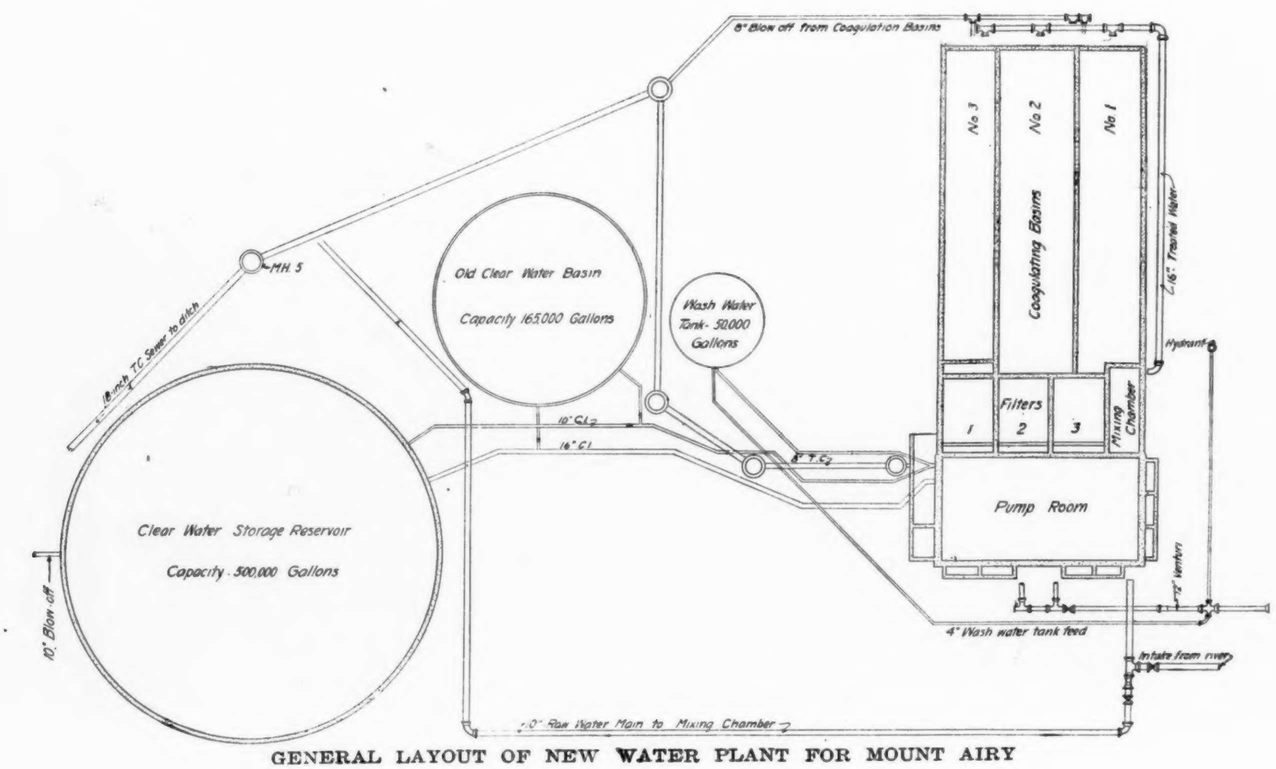
The new plant consists of a mixing chamber, three coagulating basins, three rapid sand filters, a pump house containing laboratory and chemical storage and feed machines, a clear-water reservoir and a wash-water tank.

Mixing Chamber: The mixing chamber is rectangular, with over and under baffles, designed to give a retention period of about fifteen minutes when operating at the rate of 1,500,000 gallons per day.



JOINT OF NEW WALL WITH OLD IN COAGULATING BASINS

Coagulating Basins: The old coagulating basin and mixing chamber were combined and re-divided to give two coagulating basins each about 16 ft. by 72 ft., and a new coagulating basin 12 ft. by 72 ft. was added, giving a total retention period of five hours when operating at the rate of 1,500,000 gallons per day. These are so arranged that any one of the three basins may be drained for cleaning;



GENERAL LAYOUT OF NEW WATER PLANT FOR MOUNT AIRY

BUILDING HOUSING FILTER PLANT

WASH-WATER TANK, FILTRATION PLANT AND SUPERINTENDENT'S HOME

and so that any one of the three filters may be operated with any one of the coagulating basins.

In connecting the new dividing wall to the outside walls and to the floor, a six-inch by four-inch angle was bolted over a four-inch asphaltic membrane with three-quarter inch expansion bolts, the new twelve-inch wall being centered on these angles. This gave practically a water-tight joint. The same method was used in connecting the new coagulating basin to the old one.

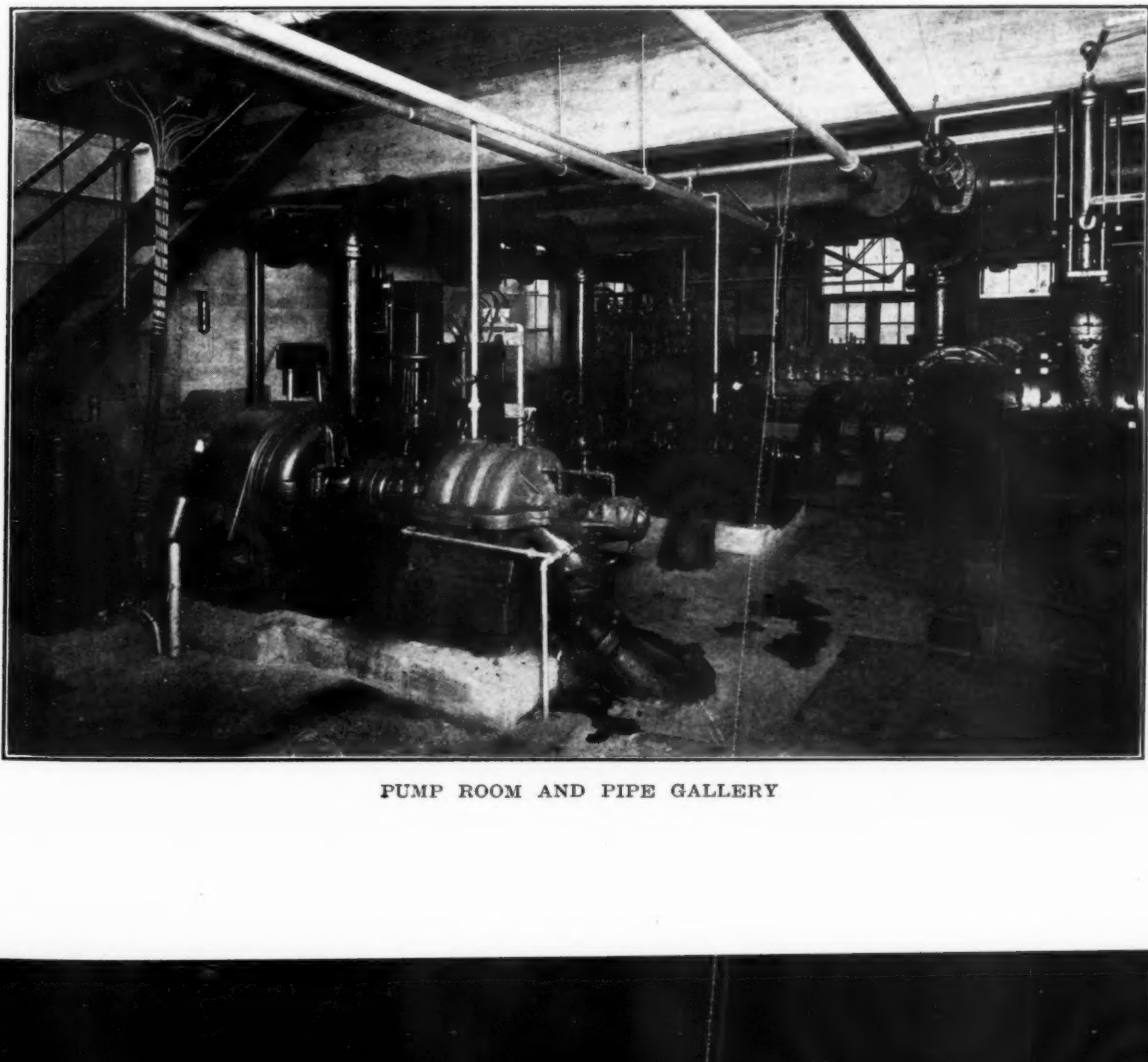
Filters: The filters are the usual rapid sand filters using filter equipment furnished by Roberts Filter Manufacturing Company of Darby, Pa. They consist of three half-million gallon units adjoining the coagulating basins, with necessary piping and operating tables, and are under the same roof as the pump room.

Pump House: Pumps, laboratory, dry feed machines, chemical storage and filters are all housed in the same two-story building. The filters are all on one side of the pipe gallery, this being a part of the pump room, which makes the piping very accessible.

Under the pipe gallery for the full width of the pump room is the suction well and filtered water conduit. The suction pipes from the pumps drop directly into this well through the floor.

The top of the suction well is below the elevation of the water in the clear water reservoir, and especial precautions were taken to prevent leakage into the pump room through the top of this well. In order to assure this, the top of the well, reinforced for upward pressure, was built six inches below the finished floor. Over this was laid heavy split wall tile or furring tile, leading to the edge of the well, at which point was put a line of drain tile surrounded by stone and leading to a manhole outside of the building. No leakage has developed to date. The floor of the pipe gallery was laid on top of this tile at the same elevation as the pump room floor.

There are three pumps: one old motor-driven pump with a capacity of 675 gallons per minute; an old gasoline engine-driven pump with a capacity of 1,500 gallons per minute for emergency fire use;



PUMP ROOM AND PIPE GALLERY

OPERATING FLOOR, SHOWING CHEMICAL FEED MACHINES

and one new motor-driven pump with a capacity of 700 gallons per minute.

In the pump room is located a 12-inch Venturi meter for measuring the raw water, connected to a recording floor stand on the operating floor; also a 12-inch Golden Anderson automatic controlling float valve for controlling the raw water as it enters the mixing chamber. An Arcola heater with radiators at various points was installed to heat the building.

Operating Floor: The second floor of the pump room houses the laboratory, a chemical storage room, three dry-feed machines, chlorine room and raw water indicator. The laboratory is very complete and is separated from the rest of the floor by a hollow tile and glass partition. The dry feed machines are used to feed alum and soda ash or lime. A chlorine room is built over a portion of one of the filters and the chlorine is fed into the filtered water as it passes into the effluent conduit over the suction well.

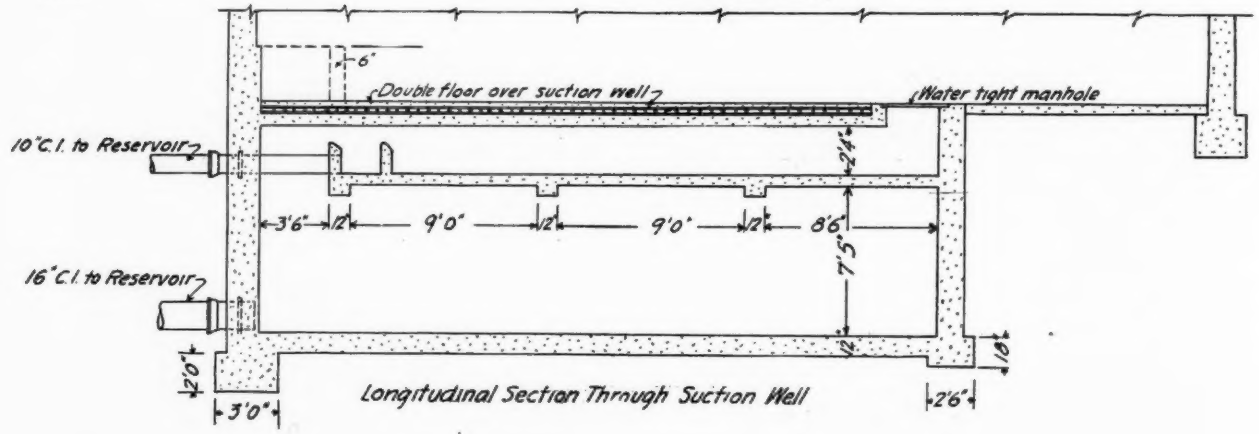
LABORATORY

Clear Water Storage: A new circular, covered, clear-water reservoir with a capacity of 500,000 gallons was constructed. Piping from the clear water conduit was so arranged that a portion of all filtered water must go to the reservoir and return to the suction well; thus the water in the reservoir is kept circulating at all times. The old clear-water reservoir will be continued in service and will be covered at a later date.

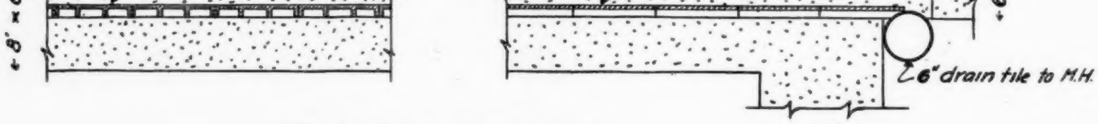
Wash-Water Tank: In the old plant no wash-water tank was provided, the filters being washed exclusively by a wash-water pump. A new elevated steel tank with a capacity of 50,000 gallons has been provided for washing the filters of the new plant.

General: Mount Airy granite being available and quite reasonable in price, the building proper was built of face brick and trimmed with this granite, making a very attractive structure. The old brick raw-water well was filled, and all the grounds around the plant graded and seeded. A seven-foot Cyclone fence was erected around the whole plant.

The total cost of the plant was around $140,000. The general contractors were Tucker and Laxton, Inc., Charlotte, N. C.



Longitudinal Section Through Suction Well



Details of Top of Suction Well

CONSTRUCTION OF WATER-TIGHT ROOF OF SUCTION WELL

A New Jersey Concrete Road Job

Methods, equipment and materials employed in construction of a concrete road twenty feet wide—thirty feet in mountainous section and in towns

The elimination of a dangerous section of mountain road has been accomplished by the reconstruction of 4.549 miles of road between Beaver Lake and Hamburg, Sussex County, N. J. This piece of road, officially designated as Section 9, Route 8, New Jersey State Highway, included a mountain section of about half a mile, where the road wound along the mountain side above a creek. Curves and heavy grade made this section dangerous, both in winter, when ice formed, and in summer, when the traffic was heavy. The new road had to follow the general route of the old road, but curves were straightened by heavy cuts and fills, the road widened, and the grade improved. Also, the section has been protected by curbs and guard rails.

Of the 4.549 miles, 1.4 miles is included in F.A.P. 85A and 3.149 miles in F.A.P. 85B. Between the termini of the contract, but being constructed under a different contract, is a section of about 2,000 feet at Hardistonville, which involves the elimination of a bad right angle and bridge.

The construction in general follows the standard specifications of the New Jersey State Highway Department. The road is of concrete, two lanes wide. The mountain section, curves, and sections passing through towns have been made 30 feet wide, while the remainder is 20 feet wide. The concrete is eight inches thick, mixed 1.1¾ : 3½, and is reinforced with a double line of deformed ⅜-inch bars in accordance with 1926 specifications. Shoulders are of natural soil, five feet wide. Carey Elastite expansion joints are placed at intervals of 37½ feet. Guard rails were required over a considerable part of the section, 11,362 feet being included in the contract. These consisted of creosoted oak posts strung with wire cable, which was furnished by the Hazard Rope Co.

The contract for the entire job was let to Salmon Bros., Inc., Netcong, N. J., for $437,313.03. It included 4.549 miles of 20 to 30-foot concrete pavement, involving 66,712 square yards of concrete, 67,426 cubic yards of earth excavation, 63,978 cubic yards of fill, and 9,696 cubic yards of rock excavation; also two bridges, one 22-foot span and the other 25 feet 5½ inches. Both of these are skew bridges of standard state highway department specifications. The shorter span is a reinforced concrete girder bridge with concrete deck; the longer, a steel girder with concrete deck. For paving these, 278 square yards of asphalt blocks were required.

Unit prices on the principal road items were as follows: Earth excavation, 90 cents a cubic yard; rock excavation, $3.10 a yard; concrete paving, $3 a square yard.

Heavy excavation was handled by two steam and one gas-air shovel, all of which were Eries. The steam shovels were equipped with ¾-yard dippers and the other with a 1-yard dipper. A crane, converted from an Erie shovel, was used at the stock yard for unloading materials from the cars and putting them in the stock bin.

A rather unusual use of these Eries was their employment in excavating the trenches for culverts and in handling and placing the 18 and 24-inch cast-iron pipes used for the culverts. This method proved very satisfactory and avoided the necessity for providing other equipment for this work. The pipe for culverts was furnished by the U. S. Cast Iron Pipe and Foundry Co.

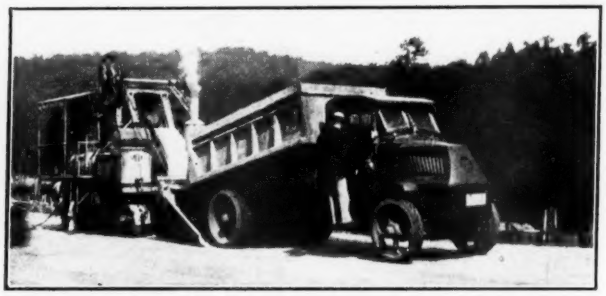
The spoil from excavation was handled by a fleet of Mack and White five-ton trucks. The number in use varied from time to time, but averaged nine. Practically all the excavated material was used for fill; as deposited by the trucks it was spread by Hadfield-Penfield one-man graders, equipped with Trackson power units. These same graders also were used on fine grading work, in conjunction with a Galion gas roller equipped with scarifier and blade. Heavy rolling of the subgrade was done by two Kelly-Springfield rollers, one gas and one steam.

Rock excavation was handled by the Erie shovels after drilling and shooting. Two air compressors were in use, an Ingersoll-Rand two-drill outfit and a Buhl one-drill. Jackhammer drills were used.

Blaw-Knox metal forms were used. Following the graders and rollers were four or five men who worked inside the forms, giving the final touches to the grade. The mixer gang was composed of about 14 men, employed as follows: Two men on the mixer; four men "in the pit," spading concrete; two

CRANE, BIN AND STOCK PILE

GRADING AND ROLLING SHOULDERS

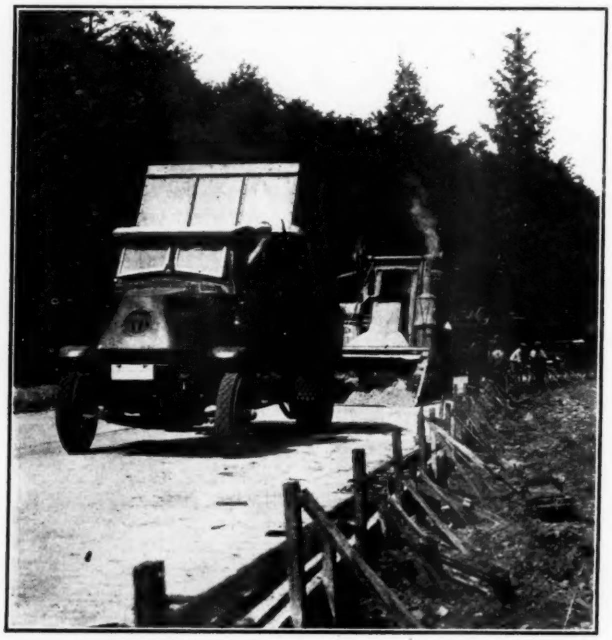


TRUCK DUMPING BATCH INTO SKIP

men on the screen; four men on the planer, and two finishers. One man was engaged in covering with hay or burlap (hay was used principally for curing) and two men tended to the watering and curing. The New Jersey standard finishing process was applied. Traffic was allowed on the road in 14 days.

Vulcanite Portland cement was used. Aggregates were brought in, no local materials being used. The stock yard being located about midway of the job, the longest haul did not much exceed two miles. As unloaded from the cars, the aggregates were stored in a Blaw-Knox bin (which has been in use for six years), whence they were hauled by trucks to the job. Mack trucks were used mainly on this work. These trucks were equipped with International four-batch bodies and Mack hoists, which equipment proved very satisfactory. Water for the mixing and curing was obtained from the creek which paralleled the road for most of its length. On a large part of the work it was possible, by taking water from the upper stretches of the creek, to eliminate pumping and employ gravity, but on the end sections a C. H. & E. pumping plant was used. A two-inch pipe line carried the water. Plugs were placed at 250-foot intervals.

Three mixers were used on the job, two Koehring five-bag mixers and one T. L. Smith 27E. All were crawler mounted. While some fairly good daily runs were made, rain interfered so consistently that



FORMS FOR CURB BEING PLACED

MOVING 160 FEET OF FORMS

nothing approaching a record was possible. Traffic also was heavy at times, but Saturday work was always possible.

Wood forms were used for the curb. These were fastened together in 160-foot sections and dragged forward by trucks, thus expediting the work. Pouring of curbs was stopped at 3.30 to allow for finishing before night.

C. A. Burn is division construction engineer in charge of the work, with headquarters at Newark. J. O. Gustofson was resident engineer, C. E. Vanderhof assistant engineer and Will Brown inspector. Herman Stephens was superintendent for the contractor, Harry Scholz assistant superintendent, Frank Gruber chief mixer operator and Pedro Moreno in charge of finishing work.

Albany's Stone Block Paving

For several years past Albany, New York, has been making earnest efforts to improve the character of its pavements and with notable success. One recognition of this was the awarding to that city by the Granite Paving Block Mfrs. Assn. of a silver cup for the best cement-grouted granite block pavement in the country.

City engineer Brennan reports that in the particular pavement which won this recognition, as well as in other recent granite block pavements laid in the city, the concrete for the foundation, and also the cement used in the grouted joints, was mixed with "Cal," both because it hastens setting and so permits early use of the pavement and also to encourage the contractor to use less water in his mixture, thus strengthening it. Mr. Brennan says that it had been found very difficult to prevent the workmen from putting more water into the cement than was desirable in order that it might work freely. The manufacturers of this material state that traffic can be turned upon the pavement two days after the cement and concrete have been placed, but in order to insure that the pavement will not be injured, Albany generally requires four days setting before the pavement is put into service.

Motor Road Equipment Economical

In a paper before the 14th Annual Road School at Purdue University, A. L. Burridge, division engineer of the Michigan State Highway Department, introduced a number of interesting points concerning the maintenance of highways. "Maintenance," said he, "should begin the day traffic commences to use the road and it should never stop. It is the only insurance you have on your original investment.

"Trying to maintain roads with old, worn-out, antiquated equipment is not only impossible but it is expensive. . . . In former years, before maintenance came to be fully recognized as of vital importance to any road system, horse-drawn equipment was used almost exclusively. With the advance of the motorized maintenance equipment and with the growing need for more intensive maintenance, horse-drawn equipment had to be abandoned and is now considered obsolete"

Mr. Burridge then compared the cost of dragging gravel roads with horse-drawn equipment with the cost of dragging the same road with a 3½-ton truck equipped with a 12-foot truck scraper attachment supplemented by heavy equipment consisting of a 10-ton tractor and heavy grader for scarifying and heavy spring cutting. "In 1927 the cost of dragging with trucks and heavy equipment on 117 miles of road having a 20-foot gravel surface and carrying approximately 1,000 vehicles per day during the dragging season was $170.95 per mile. To completely cover a 20-foot width would require two round trips with teams and patrol graders. Assuming a team could make two round trips a day on a five-mile section at a cost of $7.50 per day, the cost per year (counting 200 dragging days, which is a conservative estimate for Michigan) would be $1,500 per section or $300 per mile. The cost of doing this class of work with teams and antiquated equipment can therefore be estimated as costing almost twice as much as with motorized equipment. It seems ridiculous now to think of a highway organization using such expensive and inefficient horse-drawn dragging equipment."

Recent Trends in City Pavements*

Stronger foundations secured by increased thickness, better aggregates, more cement, better construction methods, and reinforçement. Developments in concrete and bituminous surfaces. Demand for smooth surfaces and less interference with street traffic

PAVEMENT FOUNDATIONS

Stronger foundations than we have been building are now admittedly necessary. Few have had the courage to go beyond this point and attempt to state definitely what strength is needed or what physical form would supply it. Our colleagues in the rural highway field have reduced the concrete pavement to a formula, but the assumptions on which this formula is based are not adaptable to city pavements. We are not prepared to consider the slab unsupported, and if we were, we would not be able to agree on the points or extent of the lack of support. Our slabs are broken at numerous points by manhole heads. We may attempt to lay out contraction joints, but we know full well that within a year or two new seams will be created where the repair over trenches will have met the original base. In consequence, we are still groping but we are agreed on one thing and that is that foundations must be stronger than they have been in the past.

We are trying to secure this result through various modifications of our earlier practice. The first and most evident is an increase in thickness. Six-inch bases are now being considered light traffic foundations; seven are common; and eight and nine-inch are found occasionally. Even beyond that, it is with the greatest satisfaction that we occasionally find our construction projects permitting a whole new foundation on top of a foundation, with resulting bases of from twelve to twenty inches in thickness.

Our second effort is along the lines of better selected and prepared aggregates.

Our third, a tendency to use more cement, but in doing this I feel that we are relying too much on the beam strength of the foundations and I should prefer to see the same expenditure go to increased mass. I feel this for two reasons: First, that the added strength of the pavement foundation, secured through a richer concrete, will be mainly lost after a few ditches have been run down the street; and on the other hand I feel that our additional strength should in a large measure take the phase of resistance to vibration, against which mass is our most satisfactory agent.

The fourth (the most interesting because of the possible economics involved and the most difficult because of the eternal clashing of human personalities which it brings about) is the securing of greater strength through more efficiently planned operations and more intelligent workmanship. This involves not only the determination of an economic minimum water cement ratio, but seeing that this ratio is lived up to batch after batch and day after day; and along with the proper amount of water is the proper time to secure a well mixed batch, involving, in comparison with earlier practice, generally decreased production until our contractors have learned that larger mixers are the cheaper solution; and then, the better concrete having been laid, better protection from damage by traffic and by weather is justified, and we are coming to a more scientifically thought-out and a more completely enforced system of curing.

The fifth possibility in the direction of stronger foundations involves steel reinforcement, but in our attempt intelligently to use steel, we are in the same difficulty as when we attempted to calculate a proper base thickness. We can not agree on our points of support for the application of our loads. As a result, we are generally in agreement that reinforcement can not be efficiently used in street pavement bases to secure

*Abstracts from paper before the Fourteenth Annual Road School at Purdue University, by W. W. Horner, chief engineer of sewers and streets, St. Louis, Mo.

strength, and it is now being used only in the integral concrete pavements which are, in the main, adaptations from our rural highway practice.

As a corollary to our efforts to secure stronger bases, we are definitely attempting to reduce pavement stresses through more detailed attention to our foundation subgrades and to the maintaining of smoother surfaces, thereby avoiding, insofar as possible, impact shocks.

CONCRETE SURFACES

The cement concrete pavement, which is now the standard for rural highway works, is still at a serious disadvantage as a city pavement. The more definite disadvantages are that it is not usually laid as a city pavement in sufficient quantity or continuity to permit of the type of high-class organization which the rural pavement has brought forth, and as a result more than one-half of our concrete streets are being laid under untrained supervision and by unskilled workmanship.

The same general conditions have prevented the development of high-class equipment for handling and finishing concrete on city streets. On the narrower streets, up to 26-foot roadway, finishing machines are not uncommon, and on a few of the very wide roadways concrete has been laid in alternate strips approximately under state highway practice. It is to be hoped that the rapidly increasing yardage of concrete streets will stimulate invention and production along the lines necessary to permit the city concrete to be the equal of its country cousin; but we must recognize that the existence of valve boxes and manhole heads in great numbers in all our streets will always prevent us from maintaining the smooth surface slab that we have on the road; and we must develop a greater pride of workmanship on repairs before our cut and restored concrete pavements can remain a thing of beauty.

BITUMINOUS TYPE

Today the program of all our larger cities shows hot mixed sheet pavement as its biggest item. Of the various types, sheet asphalt pavement consisting of 1½-inch binder and 1½-inch fine top mix is still the standard for use under heavy traffic.

The impetus given to the study of asphalt mixtures has spread until today under the auspices of such organizations as the American Society for Municipal Improvements, and the Association of Asphalt Paving Technologists, a wide program of research is being carried out in the laboratories of our cities and colleges of an extent and intensity approaching the work in concrete mixtures in which we are all taking a great interest.

Most of our efforts have been concentrated on securing an asphalt top mixture which will not readily displace or wave, and while well organized and wide-spread research is slowly bringing about a development of the ideal mix, we have in the meantime attempted to meet the situation by laying drier pavements (using less bitumen) and by applying harder asphalts. This trend is undoubtedly in the right direction, but extreme caution is necessary to avoid overstepping satisfactory limits which might result in asphalt pavements so loosely bound as to wear away and ravel quickly under traffic.

One result of the laying of harder asphalt pavements and of their being laid on good concrete foundations, has been the common appearance in the last few years of contraction cracks in sheet asphalt. The general public having been used to the old style plastic asphalts which would stretch indefinitely and never crack, has occasionally become excited over this new so-called "defect." Personally I do not so interpret the appearance of cracks, but feel to the contrary that they are a definite assurance that the mix is of a character which will not be displaced or waved under traffic. Such contraction cracks can be readily repaired by the same methods that are used in treating the cracks in cement concrete pavements, and when so repaired constitute no serious disadvantage.

Asphaltic concretes of several styles are in general use and have been found entirely satisfactory for lighter traveled streets. Two well known proprietary types, Warrenite Bitulithic, a coarse-graded mixture laid hot but so covered with the fine-graded "seal coat" as to have the appearance and much of the quality of sheet asphalt; and the Amiesite pavement, generally laid cold or only slightly warm and depending on the use of some solvent as kerosene to secure the plasticity necessary for laying, are both giving good service under medium and occasionally under heavy traffic, and are of distinct advantage for use in the smaller communities because of the supervision and testing service rendered by experts attached to the companies. Because of this service and the proprietary character of the pavements, they are usually somewhat higher in cost than a well-designed open specification of asphaltic concrete and occasionally cost more than sheet asphalt.

Of the unpatented asphalt concretes, the so-called Topeka specification, and the even finer-graded stone-filled sheet pavements, are the most popular. In St. Louis, we are using an asphaltic concrete two inches in thickness which consists essentially of a standard sheet asphalt mixture to which has been added about thirty per cent of stone between the ten mesh and one-half inch sizes. This pavement laid on a six-inch cement concrete foundation is costing about $2.85 per square yard or very nearly the same as our eight-inch reinforced concrete street. Its use over a period of ten years has been satisfactory in every respect and it seems to be the favorite of the general public for paving residence sections.

It is a well known fact that all types of bituminous pavements require a reasonable amount of traffic to keep them in good order, or as it is generally expressed, "ironed out." We find that such pavements which are not used appreciably dry up and crack; and on the other hand, when used for intensive parking they absorb large quantities of motor oil drippings and become soft and mucky. To meet this situation,

we are now generally laying a combination pavement in which the central strip consists of some form of bituminous sheet on a cement concrete foundation, and the side strips on which parking ocurs consist of solid concrete slabs from six inches to eight inches in thickness. On our narrower roadways of twenty-six feet, the concrete gutters are four feet in width; on thirty-six foot streets, they may be five feet; and on streets of fifty-feet or more, eight feet in width. As an indication of how this works out, a program of 800,000 yards of so-called sheet paving, will consist of 670,000 yards of bituminous center, and 130,000 yards of concrete sides. The concrete gutter, yard for yard, is cheaper than the bituminous pavement, so that the gross cost of the improvement is lowered somewhat by the adoption of the combined scheme.

DEMAND FOR SMOOTH SURFACES

City paving departments still fail to measure up to the full expectation of the citzenship in two respects. The first of these is in the matter of surface smoothness and ease of riding on our newer streets. Most of us feel that we are doing a pretty fair job in this respect, but again our country cousins, with all the advantages of highly organized mechanical equipment, are doing better, so that our city automobile owners returning from a pleasure drive outside, are filled with a mild discontent at the small jigging their wheels receive over some apparently smooth asphalt. However little criticism may be justified, the demand for further smoothness is here, and it will be up to us to set aside our self-satisfaction with our present work and find means of further improvement. I have already mentioned the disadvantage at which we are working on account of the absence of high grade mechanical equipment for the finishing of any of the types now in use on city streets. I think such equipment will be developed and that we can hasten this development if we continue to tighten up on our specifications for true pavement surface and on our efforts to see that specifications are carried out. The general adaptations of finishing machines to concrete streets does not seem to involve serious difficulties provided we once get over being satisfied with the inequalities of hand work and seriously demand something better.

In the laying of our block pavements, the use of running templates is already common, but in the case of asphaltic mixtures, we are still entirely dependent on the eye of the raker and the diligence of the roller man. I feel sure mechanical equipment for raking and leveling will be developed. I know that several agencies are studying the possibilities at this time. Only recently we have heard of a road contractor laying asphaltic concrete under a standard concrete finishing machine. The perfection of equipment for mechanical raking and rolling will require much time and experiment, and more immediate improvement must be secured by forcing more intelligent workmanship through the pressure of more intensive and careful inspection and checking. It has been hard to persuade either foreman or workman that a concrete foundation to be covered by an asphaltic mixture, has any need to be practically true in contour. If there is a defect, why not let the asphalt gang take care of it, and a lot of that has been done with the result that our asphaltic layers will often vary seventy per cent in thickness, and that rollers working on ununiform thickness must necessarily leave great variations in density as well as unfortunate waves in the surface.

We are going to specify that our foundation concretes be finished to the quarter-inch limit heretofore given to surfaces, and if necessary to secure this we are going to check our concrete bases with string lines on five foot intervals before the concrete has set. This is going to be hard work for the inspectors and harder work for the engineers to keep the inspectors doing it, but it is a task that paving engineers must undertake and carry through if they expect their work to meet with the full measure of public approval.

SPEEDING UP PAVING WORK

Citizens complain seriously of the practice of keeping the streets torn up for two or three months in front of their houses or stores for laying new pavement. Engineers have not sufficiently appreciated what serious economic losses street closing involves, but realization of it has been growing and definite efforts have been made to introduce improved methods. As an example of this definite planning, there was carried out during the past summer in St. Louis the repaving of Washington avenue, a major thoroughfare running through the retail and jobbing districts, in which the work was all done in accordance with the schedule set out in the contract and specifications. This contract provided for the removal of an old wood block wearing surface, the greater part of an old concrete foundation, the laying of a new concrete foundation, and a granite block surface with asphalt mastic filler. The contract laid down an ideal schedule which involved an elapsed time of four days from the distrubance of the old pavement to the laying of the new. On account of weather conditions and some slight labor trouble, this schedule was not lived up to in every detail but it was very nearly met. In the main, the high speed was accomplished by the introduction of night work, the requirement that concrete be mixed in a central plant and hauled onto the work as fast as needed, specifications for a quick-hardening cement, and finally a requirement for refinement of organization and supervision in every posible detail.

All of these innovations cost money, some of them not so much as might be expected, but in every single instance when the expected accomplishment was explained to the tax payer and the expected increased cost figured up, the plan met with approval.

In this particular project, the biggest item of time saving came from the use of the early-strength cement. This cement (one of several of this type now on the market) gave strengths in two days equal to twenty-eight day Portland

cement concrete. It costs less than $4.00 per barrel as compared with $2.00 for standard Portland cement. With increased production of cement of this type, there is every reason to expect further reduction in price, but even at present prices the increased cost per barrel will not exceed $1.75, and the cost per square yard for six-inch foundation wil not increase more than thirty cents. This will amount to an average increased assessment of seventy-five cents per front foot, or $30 for a forty-foot store building. For this increased cost, the saving of ten days in the time of curing concrete is secured. There would be few merchants who would not tell you that their loss on account of street closure would be in excess of $3.00 per day, and that they would gladly pay two or three times that amount to speed up a paving program.

With the full appreciation of what we are doing in the way of improved engineering and contracting to secure stronger pavements, pavements better adapted to modern traffic, and with every consideration of the necessity for economies in cost wherever possible, I feel that the biggest tasks before the city paving engineers today are to secure pavements of more perfect riding quality, and to carry out our paving construction with the least possible disturbance to living conditions or to commercial activity. Our success in these two respects is of the greatest possible importance in holding the continued support of the public to sound paving programs.

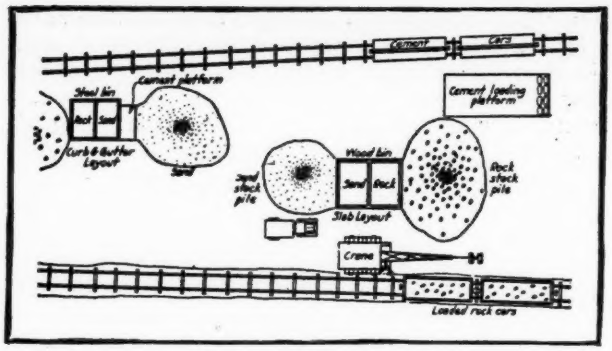
Water Cement Ratio in Lawrence

Methods and equipment employed in paving in that city, results obtained and conclusions therefrom

Last year the engineering department of Lawrence, Kansas, used the water cement ratio of designing concrete mixes for city paving, and the experience of the city is told by C. T. Hough, city engineer, and Holland Wheeler, construction engineer, of that city, in "Kansas Municipalities," the monthly publication of the League of Kansas Municipalities, from which the following is abstracted.

The existing specifications called for a 1-2-3½ mix, but the city commission decided to design water cement ratio mixes under the old specifications, but approaching very nearly the same volume as the old 1-2-3½ mix, which meant that the 3,000 pound strength recommended for paving work must be exceeded in some instances. It was also provided that no mix, based on dry, rodded volumes, was to exceed one part cement, 2.2 parts fine aggregate, and 3.6 parts coarse aggregate; and that the cement factor for one square yard of 7-inch concrete was to approach very nearly 1.17 sacks.

Some of the designed mixes exceeded the above proportions and in some cases mixes were reduced arbitrarily to meet requirements. At the close of the season, however, the excellent results obtained



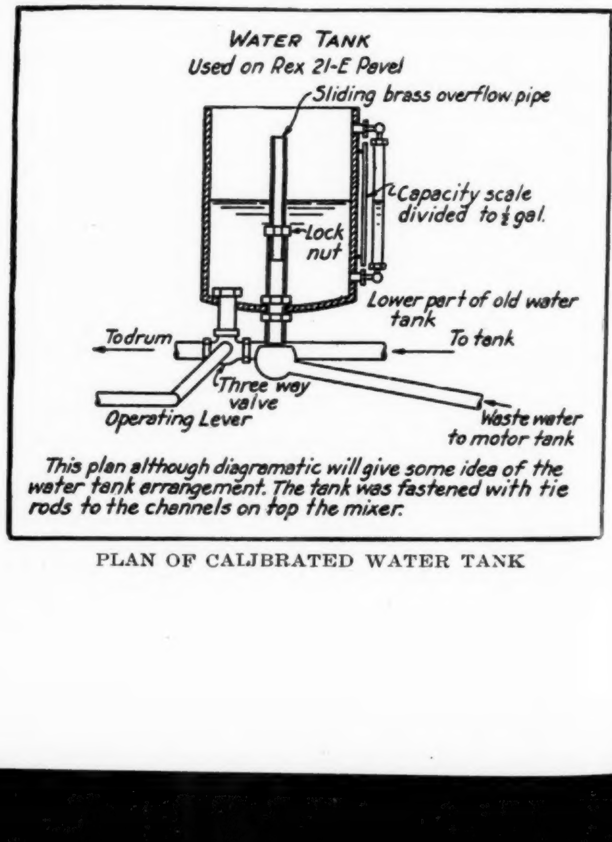
LAYOUT OF DOUBLE CENTRAL PROPORTIONING PLANT

showed that the restrictions were very fair and sound.

The only extra equipment required by the contractor, Penny & Baldwin, of Ponca City, Oklahoma, was a set of batcher plant scales for a Johnson bin and a calibrated water tank. This tank was built under the supervision of the company's engineer. The tank was used on a Rex 21-E paver with which all the slab was placed. Another tank very similar in design was built for the small stationary Rex mixer used for curb and gutter work. As the base and top mixtures required different amounts of water, the tank had to be supplied with two overflow pipes. By setting either overflow pipe at the calibrated elevation on the tank, any desired amount of mixing water could be obtained. This method of apportioning water proved satisfactory on both the large and small mixers.

The engineering department found that in order to follow out this method it was necessary for it to purchase a set of Buffalo platform scales, 250 pounds capacity, upper beam graduated to hundreths of a pound, lower beam graduated to pounds. Also a screen shaker constructed at a local carpenter shop. As a matter of fact, however, most of the tests were conducted in the state laboratory because of the late arrival of some of the city equipment.

Standard Tyler sieves numbers 4, 8, 14, 28, 48 and 100 were assembled for the sieve analysis of



PLAN OF CALIBRATED WATER TANK

fine aggregate. Several paint cans of two to five gallons capacity were cleaned and calibrated, and used in making unit weight determinations. With the addition of several flat cake pans and two refrigerator pans the laboratory equipment was complete.

The field equipment consisted of four standard 6x12″ steel cylinder moulds, each cylinder provided with a ⅜-inch faced steel plate for cap and bottom of cylinder. The tamping rod was a ¾-inch steel rod 18″ long with one end rounded to form a bullet nose. A trowel with a square end and a spatula with a 1½″ blade also were included.

The methods used were those endorsed by the American Society for Testing Materials. In sieve analyses of coarse aggregate, a sample of 75 to 125 pounds was taken from the loading bin. This sample was weighed wet, dried, and reweighed to obtain the percent of moisture. After drying, the sample was passed through sieves ranging from 2½ inch to No. 8. Dust passing the No. 8 was recorded as "Pan." The total weight retained on each sieve was recorded and the fineness modulus was calculated. The fine aggregate was handled in the same manner.

As 6 by 12-moulds were used, all unusually large rock fragments were thrown out in casting a cylinder. Each was filled in three layers and each layer was rodded. The side of the specimen was then spaded with a spatula to insure a smooth surface free from honeycomb and the top was struck flush with the mould and the specimen allowed to set for three hours. As soon as the cylinder was cast a batch of paste for capping was made up and also allowed to set for three hours. At the end of this period the paste was retempered and placed in a mound or cone shape in the center of the cylinder. The steel cap was then forced down on the paste until contact was made with the rim of the mould. After twenty-four hours the form was removed and the cylinders were stored in moist, damp sand until a short time before testing.

The bulk of the slab work was located in two districts, one in the northwest part of the city, the other in the extreme south portion. This necessitated the construction of two central proportioning plants. The plant was laid out in two complete units, one for the handling of curb and gutter work, the other for slab. The curb and gutter unit consisted of a Heltzel steel bin divided for the separation of rock and sand. Below the bin, and supported by the bin legs, was a platform on which a small one-sack Rex mixer was mounted. Above the mixer was a hopper in which the material discharged from the large bin was weighed. The cement platform was at one side, but integral with the mixing platform. Concrete was discharged from the mixer directly into the trucks.

A Johnson wood bin of about the same capacity and design as the Heltzel bin was used for the slab unit. This was erected some 50 feet north of the curb and gutter plant and was served by the same road. Below this bin and suspended on the lever arms of the batcherplant scales were two hoppers for weighing the coarse and fine aggregate.

The coarse aggregate pile was a source of considerable trouble at the beginning of the season. Shortly after unloading the sixth car of rock, the large traction gear on the crane was broken, necessitating the piling of ten or twelve cars of rock from one location. This resulted in a cone shaped pile with a great deal of coarse rock at the bottom and mostly fine at the top. In loading the bins the crane operator had great difficulty in keeping a uniformly graded rock. This in turn affected the designed mixes and on the first assumptions was thought to have caused a great part of the trouble in maintaining a workable mix with a constant quantity of water.

The first mix was designed for a "fineness modulus" of 7.50 for rock and 2.33 for sand. Excellent results were obtained with this mix when the rock gradations were uniform. Occasionally poorly graded rock and variations in moisture in the sand would cause the mix to be either barely workable or too wet. It was soon determined, however, that the moisture content of the sand had a far greater effect on the mix than the rock gradation. The wide variation of the moisture in the sand in consecutive batches was due mainly to an inadequate stock pile to which sand of different degrees of wetness was added daily, the loads at times varying as much as three per cent. in moisture content.

The mix was based upon dry, rodded volumes, the average being 1:2.31:3.50 for a 3,000-pound concrete having a 2-inch slump. These volumes were changed to weights making the proportions 94 pounds: 260 pounds: 360 pounds, to which the weight of the moisture in the sand was added.

The fineness modulus of the sand ranged from 2.30 to 2.66. A fineness modulus of 2.33 on sand was maintained in the batches using rock of 1½ to 2 inches maximum size. The fineness modulus of the rock ranged from 6.44 to 8.07, a considerable variation. As stated previously, however, the variation in rock fineness modulus did not have as much effect upon the resulting mixes as did the moisture content of the sand.

TEST CYLINDER RECORD							
CURB AND GUTTER CYLINDERS							
No.	Date Made	Date Tested	7 Day Strength	28 Day Prediction	28 Day Strength	Mix	Designed for
1	6-27-27	7-4-27	1260 lb.	2325 lb.	3060 lb.	1:2:4	
2	6-27-27	7-5-27	1750 lb.	3007 lb.	3100 lb.	1:2.4:3.3	3000 lb.
3	6-28-27	7-6-27	1828 lb.	3110 lb.		"	"
4	6-28-27	7-28-27			1400 lb.	"	"
5	6-30-27	7-7-27	1583 lb.	2778 lb.		"	"
6	6-30-27	7-28-27			2260 lb.	"	"
7	7-1-27	7-8-27	2118 lb.	3498 lb.		"	"
8	7-1-27	7-29-27			3200 lb.	"	"
9	7-2-27	7-9-27	1470 lb.	2620 lb.			
10	7-2-27	7-30-27			2950 lb.	"	"
17	7-9-27	7-16-27	2425 lb.	3905 lb.		"	"
18	7-9-27	8-2-27			3700 lb.	"	"
SLAB CYLINDERS							
101	7-12-27	7-19-27	2335 lb.	3777 lb.		1:2.31:3.50	"
100	7-12-27	8-9-27			3620 lb.	"	"
104	7-19-27	7-26-27	2220 lb.	3620 lb.		"	3250 lb.
105	7-19-27	8-16-27			3520 lb.	"	"
106	7-22-27	7-29-27	3580 lb.	5375 lb.		1:2:3.5	"
107	7-22-27	8-19-27	1926 Mix		4750 lb.	"	
110	7-25-27	8-1-27	4060 lb.	2995 lb.		1:2.15:3.5	3500 lb.
111	7-25-27	8-22-27			4830 lb.	"	"
116	8-1-27	8-8-27	2750 lb.	4322 lb.	3750 lb.		
117	8-5-27	9-2-27			3100 lb.	1:2.11:3.73	3375 lb.
119	8-6-27	9-3-27			3950 lb.	"	"
120	8-6-27	8-13-27	1990 lb.	3330 lb.		"	"
131	8-8-27	9-10-27			3400 lb.	1:2.30:3.41	"
132	8-18-27	8-25-27	2370 lb.	3830 lb.		"	"
137	8-22-27	9-13-27			3510 lb.	"	"
138	8-22-27	8-29-27	2230 lb.	3640 lb.		"	"
145	9-13-27	9-20-27	2810 lb.				
146	9-13-27	10-4-27			3350 lb.	1:2.13:3.60	"

TEST CYLINDER RECORD SHEET. COMPARISONS CAN BE MADE BETWEEN THE DESIGNED STRENGTHS AND STRENGTHS ACTUALLY SECURED

As a result of this trial our conclusions are as follows:

1. As the work progressed, both the contractors' and engineers' organizations became more experienced in the use of water-cement ratio and were more able to keep the mixtures under control; hence a more uniform concrete was obtained as shown by test records.

2. No appreciable saving in cost was made on this season's work due to the fact that the saving in cement was offset by increased engineering cost. This increased cost of engineering will be reduced in the future due to the experience gained during the past season.

3. The use of water-cement ratio will automatically increase efficiency about the plant, and will call attention to conditions which are ordinarily overlooked, such as inadequate and poorly graded stock piles, and mechanical features of plant equipment which may be obsolete or in bad repair.

When contemplating the use of water-cement ratio it is suggested that the minimum allowable strength be determined with a margin of safety in case there are no facilities for making cylinder tests as a check on the determinations.

5. It is our intention to continue the use of water-cement ratio in the future so long as the successful bidder on the season's work is willing to co-operate and produce the desired results. However, contracts for the work will in all probability be drawn up with water-cement ratio as an alternate, until such a time that its use is more universally adopted by engineers and contractors in this line of work.

Moving Pictures as Contract Records

We have referred two or three times to the advantages of the taking of photopraphs, by engineers and contractors, of the progress of work which is under their supervision. This idea has been extended to the use of moving pictures for this purpose. A contractor engaged in constructing buildings in Chicago visits his various jobs several times during the week, going to the top of nearby buildings while important operations are in progress and there taking moving camera shots of what is going on. At the end of each week all foremen and superintendents gather in the office to view the pictures that have been taken, and discover and discuss such features as are brought out by the movies but were not noticeable to the man on the operation itself. It is said that in this way many little points are discovered and acted upon which aid in reducing the cost of the work. The more important features of the work as brought out by the movie films are saved and filed as a permanent record of the job.

Mechanical Spreading, Raking, Finishing of Asphalt Concrete Pavement*

By C. S. Pope, Mem. Am. Soc. C. E.†

The desirability of securing a machine which would mechanically spread, rake and finish asphaltic concrete has been evident for many years.

Objection has been made in the past that any machine used for spreading and finishing Portland cement concrete would not be suitable for asphaltic concrete, because the asphaltic concrete would stick to the spreading and leveling devices if they were not heated or oiled, and further, that such machines were not provided with suitable rakes which are essential in asphaltic concrete construction.

It was the belief of the writer that the use of an ordinary spreading machine such as is used for spreading and kneading or tamping Portland cement concrete pavement would not give the results which were desired and therefore it was decided to remodel an Ord finishing machine by placing a rake in the machine in such a position that it would satisfactorily rake the material into longitudinal furrows. It was thought extremely important that the furrows should be longitudinal, since the material would then be raked in such a manner that if there was any incipient deformation, it will be through the formation of longitudinal ruts of slight elevation rather than through the formation of transverse waves which are the curse of pavements of this type.

The machine described herein was placed on a contract for asphaltic concrete surfacing, some eight miles in length in Kern county, California, near the town of Delano. Its success was almost immediately evident and led not only to the purchase of the machine by the contractor but also to the purchase of a similar machine for an adjoining contract of similar length.

The machine consists essentially of a motor-driven steel framework running on flanged wheels resting on the side forms.

A spreading blade, which is adjustable for height, spans the width of the pavement at the front end of the machine.

Back of the blade, the raking teeth, which are inclined to lift the mixture, are arranged in rows attached to shafts or channels in such a manner that they may be lifted or given any desired inclination.

So far, the work indicates that two rows of teeth spaced six-inch centers are sufficient.

Such an arrangement forms the furrows three inches on centers and gives a sufficient loosening and distributing action.

Back of the raking teeth is a second strike-off and finishing plate also spanning the full width of the pavement.

* From "California Highways and Public Works."
† Construction Engineer, Division of Highways.

The strike-off plates are adjusted to the proper elevation by means of hand wheels.

Both strike-off plates are set vertical and have a sidewise motion which shears the material and permits the machine to advance with the use of a minimum of power. While the present rakes do not vibrate, it is planned that they shall be arranged to do so in subsequent machines.

The raking apparatus was, therefore, so arranged that the furrows should be made longitudinally and practically straight. Should a slight waviness of the furrows ocur, due to the necessity of vibrating the teeth, it will probably not be found detrimental. The use of teeth is believed essential to secure uniform texture in the mixture upon the road.

In the practice it was found that, in cases where the mixture was piled up in front of the screeds or strike-off blades to a greater extent near one end than at the other, without the use of the rakes, certain areas showed that an increased weight of material had been accumulated by being packed down under the weight of the first screed, and the second screed by merely continuing the process gave a pavement, which, while it had a smooth surface, was really of non-uniform density in different parts of the cross-section. The use of the rake broke up this condition and allowed the second screed to spread the material more uniformly than if the rakes were not used.

The use of the raking and finishing machine will, it is believed, accomplish several objects. One of these is that it removes the unevenness of surface which causes shock and therefore deformation of the pavement, and the other is that it gives a proper distribution of material over the whole surface so that there is no possibility of any accumulation of material in any one area which would have a density different from that of the rest of the pavement, which would lead to an uneven cross-section or a high place in the surface.

PAVING OPERATION

The most efficient method of operation in the widening and surfacing of an old pavement is as follows:

The shoulder widening is first spread to the level of the old paving and rolled. The old concrete base is painted with a coat of emulsified asphalt, which provides a tack coat for the leveling course.

The header boards or side forms, which are of wood three inches in width, are set to the grade of the leveling course or base.

The asphaltic concrete mixture is hauled to the work in 3½-ton, pneumatic-tired trucks and is spread by means of small spreader boxes for the shoulder widening and by large boxes about nine feet in width for the leveling course or base.

The spreader boxes distribute the hot mix in excellent position for subsequent work.

The mechanical finisher is then set to work spreading, raking and finishing the leveling course and is immediately followed by the rollers necessary to compress the asphaltic concrete.

After the leveling course has progressed a sufficient distance, the mechanical finisher is returned to the location of the surface already spread and the spreading of the surface is begun.

In order to secure the thickness required for the surface course, a wood strip 1½ or 2 inches in thickness is nailed on the base of leveling course side form; and to secure the necessary extra height of surface required to compensate for the compression of the asphaltic concrete surface given by the rollers, steel plates ⅜ inch in thickness by 3 inches in width are temporarily nailed to the top of the header strips. These plates are removed just in front of the rolling.

After the first passage of the rollers over the surface, the finish coat or void filling coat consisting of fine broken stone or gravel coated with asphaltic cement is drifted onto the surface and immediately rolled into the pavement. The result is a smooth, uniform, nonskid surface.

The spreading, raking and finishing machine operates at a speed of about 250 feet per hour and will easily spread 400 tons of hot mixture per day, on a 20-foot width of roadway.

ADVANTAGES

The advantages obtained by the use of this machine consists of:

(a) Economy of material;
(b) Decrease in hand labor;
(c) Increase in smoothness of paving.

In ordinary hand-raked work, even with careful supervision, there is a loss or excess of material used, due to uneven spreading of base or surface. The cross-section of the finished pavement may vary considerably from the established cross-section and yet not be apparent to the eye. Also, there may be a uniform thickening of surface which is not observable even though the cros-section be correct. With the use of these machines, this extra material is very largely saved and its amount is estimated by engineers in the field at from 3 to 10 per cent of the material used for surfacing.

Ordinarily, the spreading of surface course 1½ inch in thickness is a difficult matter, but with this machine it presents no difficulty whatever.

With asphalt concrete running from 1,200 to 1,800 tons per mile on 20-foot resurface at about $5.50 per ton, the possible economy is readily apparent.

The immediate decrease in hand labor is not at once apparent, though on one contract the labor crew is reduced to nine men including the foreman and machine operator for the spreading of 400 tons of mixture per 8-hour day. It is probable that future work will show a further reduction in labor so that the ultimate saving in men will be sufficient to influence a reduction in the prices bid for paving.

On asphaltic concrete spread by hand methods, tests made under the direction of the author indicate that an average smoothness of 18 units of roughness per mile, as shown by a roughometer such as is used by the Bureau of Public Roads, was about the low limit that could be expected. This was about three times the roughness obtained on the best Portland cement concrete pavement on its completion.

The first few days' use of the asphalt concrete finishing machine indicated that a roughness of not more than 10 units per mile could readily be obtained and that side sway of motor cars due to uneven cross-section was greatly reduced.

Since it is necessary to move the machine back on the job for the construction of surface after having laid base, means must be provided for its rapid transportation.

It is the opinion of the writer that the development of this machine presents a distinct advance in the art of paving as applied to asphaltic concrete and one that will have a far-reaching effect on the use of this material.

While the original idea of a mechanical finisher and its general details orignated with and was pushed to a conlcusion by the author, credit is due to many others for thoughts and ideas contributed during the construction and operation of the trial machine.

During May, 1927, W. F. Herin, assistant resident engineer, and H. B. LaForge, resident engineer, in discussing the matter of more efficient spreading, advanced the idea that material might be spread by the use of strike-off blades by hand. The author felt that it would be necessary to include a rake for the experimental work and that eventually the whole operation should be done by machine.

The first experiments were carried out by Earl Whithycombe, assistant contruction engineer, on work near Merced and near Larkspur. These were so successful that arrangements were made with the Edward R. Bacon Company to secure an Ord tamper which was remodeled for the more extensive experiment. This machine was put in use, as stated before, during the latter part of September or early in October. Many points had to be worked out in the field for which great credit is due to Mr. Withycombe and also the contractors, Force, Currigan & McLeod, who assisted in putting the machine on a sound working basis. There seems little doubt that the small expense to which the state has been subjected in the development of this machine will be repaid many times over in the better and more economical pavements which can be laid with this method.

Covered Sprinkling Filter For Totowa

Speaking before the New Jersey Sewage Works Association, as part of a discussion on the control of odors given off by sewage treatment plants, Charles Capen described in a general way a plant being built for the Borough of Totowa, N. J., on the Passaic river about two miles above the Great Falls of Paterson, all of which plant is to be covered, hot-house glass construction being used for the sprinkling filters as well as for the sludge drying beds.

The effluent had to be discharged into the Passaic river above a point where it is used for bathing, which required considerable purification; in addition to which it was located within a very short distance of a bungalow colony and therefore any nuisance from odors had to be prevented. To prevent water polution, bar screens and a grit chamber were provided, two-story settling tanks, dosing tank, sprinkling filter, chlorination and final settling basins. The screen and grit chamber in one unit, together with the settling basins, are housed in a concrete block structure finished with white stucco and trimmed with red tapestry brick. The dosing tanks will be covered with a concrete roof. The sludge beds will be covered with a glass roof of hothouse construction, as will also the sprinkling filter. The final settling basin will be covered with a concrete roof. There is no point in the entire plant in which the sewage will be outside of some form of housing.

The area of the filter bed was nearly 10,000 square feet and the use of frame and steel covers or roofs was not considered favorably, and glass was decided upon, having already been selected for covering the sludge beds.

The construction of hot-house type of glass roof has been more or less standardized as to size, and this did not fit the original plan for the sprinkling filter, but it was considered easier to adjust the sprinkler filter to the standard roof than the roof to the sprinkling filter. A so-called 80-foot span as built at the Boonton plant was selected as being suitable, and the dimension of the sprinkling filter were adapted to this building. The length was made such that a standard length of trussed section of the glass house could be used, the final bed area being then slightly in excess of that required.

The requirements of the New Jersey State Board of Health provide for 300,000 gallons of sewage treated per acre of sprinkling per foot of effective depth, and it would therefore be more economical to build a deeper filter and thus reduce the area of glass covering. The Totowa filter was designed for a depth of nearly seven feet.

The enclosing of all the structures was of course only half the problem, since the gases and possible odors remained to be disposed of in some way. Large vitrified tile ducts will lead from the sprinkling filter, sludge beds and settling basin superstructure to a blower located in the chlorinator house. An arrangement will be made to shut off one or more of these units as desired. The blower will discharge the gases into a wooden flume into which a small quantity of chlorine gas will be introduced. A period of contact will complete the chemical combination of the chlorine with the organic substances responsible for odors before they are discharged into the atmosphere.

It is believed that not only will the glass covering prevent the dissemination of odors from the sprinkling filters, but that it will maintain the sewage and the beds at a higher temperature in winter and thus insure greater efficiency at that time.

In discussing the paper, Wellington Donaldson (of Fuller & McClintock) called attention to the fact that years ago, probably between 1890 and 1896, a plant was built at Mt. Vernon, New York, in which septic tanks and sprinkling filters were covered with glass roofs, and suction was used to exhaust the air and discharge it into towers or chimneys. At Decatur, Illinois, it was found necessary on account of the production of hydrogen sulphide odors to cover the grit chambers, the gas vents of

the Imhoff tanks and all the conduits around the Imhoff tank, and these gasses were collected and burned. Also P. N. Daniels stated that in Pennsylvania there are a number of instances where trickling filters have been housed over for the prevention of nuisance from odors. Probably, however, the Mt. Vernon plant is the only one in which sprinkling filters have been covered with glass, previous to the Totowa plant.

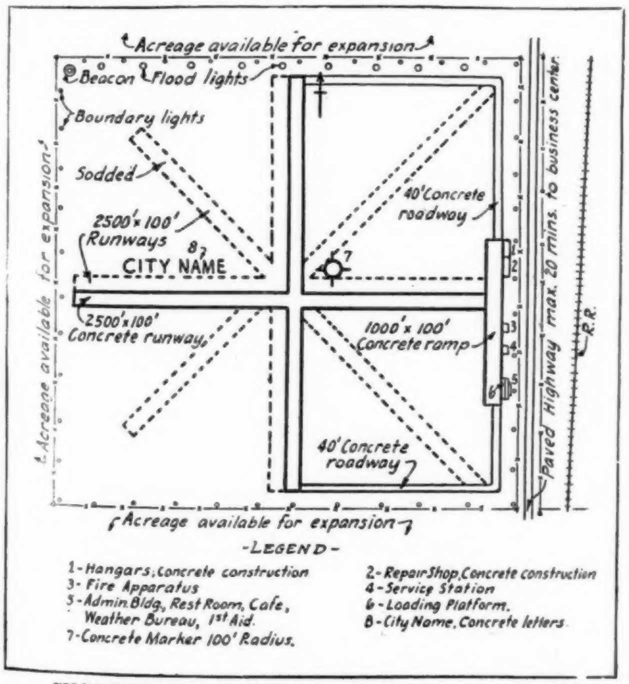
Municipal Airports

General suggestions for laying out municipal air ports. Size, drainage, runways and buildings. Rating of airports

In a recent article entitled "Layout Planning for Municipal Airports," Carl H. Wolfley, of St. Joseph, Mo., a consulting aeronautic engineer and chairman of the Committee on Airports and Airways of the National Aeronautic Association, gives briefly some ideas concerning the laying out of municipal airports, which are abstracted below.

The layout should provide hard surface for landing and taking-off; hangars, repair shop and service station; standard markers for the field and lighting; parking space for automobiles, taxis and buses, and the usual utilities including water, sewers, gas, electricity and telephones. If not provided for elsewhere, the administration building should include passenger and express depot, a rest room, sleeping quarters for the personnel and pilots, restaurants, first aid facilities and provisions for weather bureau reports.

The size and shape of the field will be somewhat dependent upon local conditions. Every city planning a first class airport will, however, have at least the space necessary for a layout such as is shown in the accompanying sketch of a model airport. The area provided for future expansion will depend upon the city.



SUGGESTED LAYOUT FOR A MODERN AIRPORT

As to capacity of airport, at the present time several airports in the United States are handling about 1,200 planes a month. The leading factories this year have more orders than they can fill and several thousand new planes will be put into service shortly, and it is believed to be a conservative estimate that we can expect five million planes in operation in this country at the end of the next ten or fifteen years. Even today a first-class airport should be equipped for planes landing or taking off every five or ten minutes.

It is recommended that in the beginning all buildings be located along one side of the field in order to concentrate alministration and service facilities. This leaves the entire field free for planes landing and taking off under favorable conditions without obstructions and also leaves the field free for expansion in three directions.

The necessary buildings should be of permanent construction, fireproof and weather proof. A conventional size for a hangar today is 100 feet wide and 120 to 140 feet long with 18-foot clearance throughout the inside. A truss roof should be used. Reinforced concrete, cement block, stucco or other masonry materials may be used for the walls. Masonry walls are recommended in every location to assist in keeping the building warm in winter and cool in summer. A good amount of window area should be provided and skylights used where center lighting is desired. Concrete strips or ramps 100 feet wide should extend along the front and sides of the hangars and connect with the runways. Modern service stations for oil and gasoline should be constructed. It is recommended that pipe lines lead in various directions to points on the field where the service of air, water and gasoline may be rendered from storage pits covered by trap doors. The general scheme for the buildings should provide an arrangement that will be attractive and dignified. A reasonable amount of space for flower beds and shrubs around the building is highly desirable.

The sketch of the model airport shows eight landing strips meeting at the center. Each has a minimum length of 2,500 feet clear. Another layout might not show all these intersecting, but the sketch shows the greatest economy in space where a landing strip is provided in every principal direction.

In the case of most fields the surface needs drainage and usually underground piping to remove surface water as soon as possible after a storm. In the northern states an otherwise good field will be rough in winter when slight irregularities are frozen. In the long run the cheapest construction to give a hard, smooth surface in all weather and all seasons of the year is concrete for the runway surface. The natural surface adjoining should be seeded down with a grass that is suitable for the climate. In many cases blue grass and clover will be best. It will take 12 or 14 months of good care to secure a permanent sod. Even with an all-over type of field, at least two concrete runways affording four-point landing and takeoff are recommended. Concrete

landing strips as shown will ajoin the natural runway.

Many commercial planes today weigh from five to seven tons, but heavier weights must be expected. It is advisable that the runways be constructed to carry loads of at least twenty-five to thirty thousand pounds. Each concrete runway should be at least 100 feet wide, although on fields of lesser importance it may be possible to get along for a few years with half this width. Concrete connections should be extended from the runways to the ramps and hangars. On some fields runways have been constructed of cinders or surface-treated stone or slag. As a business proposition this construction can not be recommended. Cinders are always dirty, and blown up by the wind from the propeller, may seriously damage the propeller or engine. Other light types of surfacing are expensive to maintain and when constructed for the load to be carried will cost almost as much as the concrete and lack concrete's durability.

Where the airport can be located on a body or water of sufficient size, additional provisions should be made for amphibians or seaplanes. Since these planes will land and take off from the water, buildings for their accommodation will be located along the shore and one or more concrete runways will extend from the ramp to a point several feet below the surface of low water.

Mr. Wolfley gives a table listing the features to be considered in the layout of a modern airport and conforming in most respects to the preliminary requirements to the U. S. Department of Commerce.

Proposed Rating and Comparison of Commercial Air Ports

Items	Class First	Second	Third	Fourth	Fifth
1. No. of runways 200 ft. wide or paved strips 100 ft. wide safe in all weather	8	8	4	3	2
A. Total distance in clear each direction	3,000	2,500	2,000	1,500	1,200
B. Capacity; planes per day	500	500	250	150	100
2. Acreage and available for expansion	600	400	300	200	100
3. No. of Hangars 60'x100'x15' or larger	4	2	1	1	—
4. Repair Shop	1	1	1	—	—
5. Service Station	1	1	1	1	—
6. Fire Apparatus	1	1	1	1	—
7. Administration Building	1	1	—	—	—
A. Rest Room	1	1	—	—	—
B. Passenger and Express Depot	1	1	1	—	—
C. Sleeping Quarters	1	1	—	—	—
D. Restaurant	1	1	—	—	—
E. First Aid Facilities	1	1	1	—	—
F. Register of Arrivals and Departures	1	1	1	—	—
G. Weather Records and Reports	1	1	1	—	—
H. Utilities—Sewers, Water, Gas, Elec., and Telephone	1	1	1	1	—
8. Improved Highways to Civic Center	1	1	1	1	1
A. Regular Transportation Service Day and Night	1	1	Day	Day	—
9. Railways Facilities—Siding Space	1	1	—	—	—
10. Automobile Parking Space—Cars	500	300	200	—	—
11. Lighting and Signals					
A. Boundary Lights	1	1	1	—	—
B. Flood Lights	1	1	1	—	—
C. Hangar Lights	1	1	—	—	—
D. Code Lights	1	1	—	—	—
E. Beacon Lights	1	1	—	—	—
F. Ceiling Projector	1	1	—	—	—
G. All Night Service	1	1	—	—	—
12. All Year Drainage System for Field	1	1	1	1	—
13. Standard markers					
A. Center Marker	1	1	1	1	1
B. Wind Indicator	1	1	1	1	1
C. Magnetic Meridian	1	1	1	—	—
D. Station Name and Code No.	1	1	1	1	—
14. Adequate Seaplane Accommodations					
A. Water Area Similar to Land Area	1	1	1	1	1
B. Runways	2	1	—	—	—
C. Hangars	2	1	—	—	—
15. Accommodations for Dirigibles					
A. Mooring Mast	1	1	1	—	—
B. Hangar	1	1	—	—	—

Putting Imhoff Tanks Into Service

Experiences at Newcastle, Penn., and Trenton, N. J. Dosing accumulation of undigested sludge with lime. Underdosing is wasteful and futile

Difficulties experienced in connection with the starting of actual operation of the Imhoff tank plant at Newcastle, Pa., and the conclusions drawn therefrom were described by Wellington Donaldson in a paper before the convention of the New Jersey Sewage Works Association.

The Newcastle plant consisted of bar screens, with 2-inch spacing, Imhoff tanks with concrete roofs for collecting gas, a pumping station, and open sludge beds. The plants were put into operation on October 16, 1926, and at first nothing abnormal was noticed except that the amount of gas produced was low. However, the following April the sludge

was found to have an acid reaction with a p H of 5.2 to 6.8 in various tanks and a CO_2 percentage in the gas from the tanks of nearly 50%. In order to correct this acidity, hydrated lime was added. Best results were found by adding lime to the suction of a sludge pump, while this was circulating the entire contents of a tank, until a pH of 7.6 was obtained. By September 7th 60,232 pounds had been so used.

"The outstanding effect of the liming procedure was prompt increase in bacterial activity in the tanks as evidenced by the amount of gas passing the station meter and later by very pronounced foaming, although the reaction of the tanks was unquestionably maintained within the supposedly optimum range of about 7.5. This foaming was believed due not to faulty adjustment of reaction but to the excessive amount of solids which had accumulated during the winter season and were not yet digested."

It was found impossible for the tanks to digest all the previous winter's accumulation by the end of that summer, and in November advantage was taken of high river stages to unload sludge from three of the tanks into the river, and use these as settling tanks, while sludge was allowed to remain and digest in the other three, which served therefore temporarily as separate sludge digestion tanks. Last spring the accumulated ripe sludge in these three tanks was distributed among the other tanks, and apparently all six will soon be, if they are not already, operating favorably.

When the tanks first started operation they produced only about 50 to 100 cubic feet of gas daily, although according to the usual assumption they should have produced about 17,000 cubic feet. After the heavy liming, the quantity produced reached a maximum of 25,000 cubic feet. During the winter the gas produced by the three tanks which were operating as sludge digestion tanks was burned in small stoves as heat two small buildings on the grounds.

Another difficulty experienced in the operation of these tanks was that caused by the scum collecting in the upper spaces of the gas roof and in the gas bells. This caused clogging of the screens under the 36 gas bells and necessitated frequent removal of them and of the screens for cleaning. Other types of screens have been experimented with and the spacing of the rack screen ahead of the tank was changed from two inches to one inch in order to intercept more of the troublesome floating material.

Based on these experiences, the author has drawn certain conclusions as follows:

In treating tanks which have a large accumulation of unripe sludge, the addition of lime to the upper part of the digestion compartment is not satisfactory or economical. It is best to turn over the entire contents of the tank with a pump and add lime while pumping.

In dosing acid tanks with lime, it is wasteful and futile to undertreat. Unless the reaction is made definitely alkaline, the lime added apparently serves to stimulate acid-producing activity and the effect is soon lost.

In treating an accumulation of undigested sludge, the collection of samples one or two feet above the sludge line is not a satisfactory criterion for lime dosing. In such cases, the sludge itself and the supernatent liquid must be brought to the desired reaction.

The quality of lime is of considerable importance where large quantities are used. Hydrated lime of high magnesium content is the most economical reagent for neutralizing acidity. High calcium lime is more expensive.

The percentage of CO_2 in the gas resulting from decomposition of sewage solids would seem to be a satisfactory indication of the progress of digestion. With covered digestion tanks the CO_2 percentage appears to be a useful warning of abnormality in tank behavior, thus giving an early indication of the need of corrective treatment.

Following Mr. Donaldson's paper, P. N. Daniels, city sanitary engineer of Trenton, N. J., told of experiences in beginning the operation of Imhoff tanks in that city. It had been calculated that about 3,000 cubic yards of material would be required for seeding the tanks and therefore the tanks were started without seeding, but a small amount of lime was added with the idea of preventing acidity. On May 26 lime was added at the rate of 15 pounds per thousand gallons, which was doubled on June 11 and on July 6 the rate was raised to 75 pounds, as one of the tanks began to show appearance of foaming. During the latter half of July sludge was drawn from all of the tanks on account of its accumulation and was found to be fairly satisfactory in appearance, but the pH of the tanks remained slightly below 7.0, even though the lime was increased to 375 pounds per million gallons, and about the middle of August foaming started. 750 pounds per million gallons was then employed and the pH changed to 7.0 and foaming ceased.

The lime dosage was then reduced to about 110 lbs., and the pH remained at 7.3. Like Mr. Donaldson, Mr. Daniels believed that "a saving in lime would have resulted had an initial alkalinity been set up at the start."

Improving the Appearance of Disposal Works*

There is a moral effect in keeping a plant clean and attractive. Brass work in an engine room is a source of pride to the man who polishes it. The operator in charge of a station, where a well considered plan in a suitable setting gives a neat appearance, will put forth his best efforts, not only to have his plant appear well, but to have it function properly. Walls and floors should be kept clean and washed down at least daily to remove molds which produce odors and attract flies.

When additional funds are required for extensions or new units, the taxpayers who have visited an attractive plant, who have been well received and have found that it is not such a pest hole as they had imagined, these are the ones who most cheerfully vote the moneys.

Of course, if possible, the plant should be located in a valley protected on as many sides as may be by forest and not to windward of inhabited territory.

*From a paper before the New Jersey Sewage Works Ass'n, by John F. Skinner, deputy engineer, Rochester, N. Y.

These ideal conditions may not generally obtain, but they should be sought and approximated.

Screens of natural forest trees not only prevent access of winds which transport odors, but both forest trees and artificial plantings of trees and shrubs, by means of their cool, moist leaves, furnish surfaces upon which odoriferous vapors may be condensed and gases absorbed.

If trees and shrubs which give off pleasant odors are planted about the premises in masses sufficient to affect the atmosphere, they will be noticed at times for their beauty and for their pleasant odors and at other times will serve to disguise unpleasant odors by their presence.

The psychological is ever to be considered in such matters. Indeep Mr. Cohn of Schenectady says "most odors reported from sewage disposal plants have little to do with the olfactory senses. They originate in the brain and are the result of overactive imagination."

Naturalistic planting about the station where it must be exposed and screens of trees and shrubbery to mask it where possible, do much to prevent imaginary odors from causing annoyance.

The nerve sensation called smell may be forgotten if other interests are paramount.

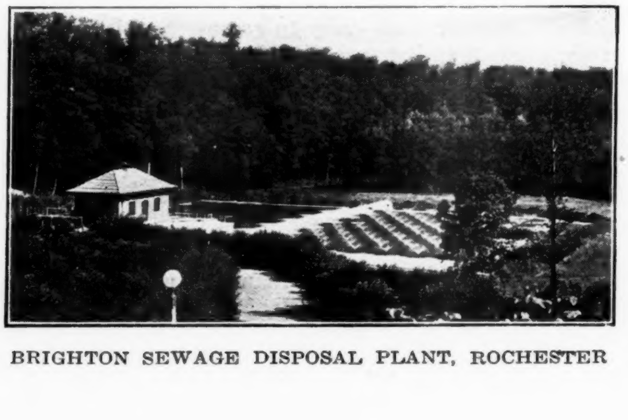
A small Imhoff and trickling filter plant designed and constructed by the writer, which has functioned continuously for 12 years, has been particularly successful in operation, and due to co-operation of our Park Department the surroundings have been made really beautiful.

The natural setting is all that could be desired. The plant is in a valley closed in by hills and forest on the north, west and south, and opens on the east upon an uninhabited marshy flat a mile and half wide. The sewage has a fall of 75 feet which is utilized in the station and the prevailing winds are from the west. A winding road has been constructed down the hill and the rustic fence along this road and the high wire fence around the plant are each covered with the climbing rosastetigera which blossoms profusely in mid-summer.

The operator takes pains to inform his visitors that the roses and the other shrubs are fertilized by sludge, the product of the tanks.

The planting includes red stemmed dogwood, barberries and several vibernums, the berries feeding the birds and the chestnut trees of the forest attracting the squirrels.

All summer long groups of people come to the site with their lunches and picnic on the grounds.



BRIGHTON SEWAGE DISPOSAL PLANT, ROCHESTER

Along a little wooded ridge north of the filters there are perhaps a dozen rude fireplaces built of the flat stones found embedded in this glacial drift, and over these the sausages are roasted and the coffee boiled. We have lately built picnic tables and provided water supply and may erect a rustic comfort station similar to those used in the Western Parks.

Certain men must be kept busy around a municipal plant and it is as well to select some who have a love for outdoor things and pride in making beautiful things grow where none grew before.

Markers on New York Highways

Prior to 1924 the signs upon the New York state highway system varied in design and were merely painted wooden boards. In 1924 the highway department adopted a uniform system of marking state routes with durable cast iron signs. At especially dangerous points there were also erected large wooden signs known as checkerboard signs, while at other dangerous points reflector signals have been placed and proved useful for night driving.

Probably the greatest aid to the tourists was introduced in 1925, when the department began numbering all of the improved highways, these numbers being painted on telegraph poles, bridge abutments and other conspicuous places along the road.

In addition to several thousands of the old wooden signs which for one reason or another have not as yet been replaced, the state since 1923 has erected upon the state highways 33,313 cast iron direction and warnnig signs at a cost of approximately $333,000,- 1242 large danger signs at a cost of $37,000, 54,852 painted route numbers at a cost of $80,000, and 2,102 red reflectors at a cost of $60,000. A total of 91,509 traffic guides at a cost of about $510,000.

There is now a total of 10,208 miles of improved state highways under the jurisdiction of the state department and therefore nine traffic guides to every mile of highway or an average of one sign to each 587 linear feet of road.

Frederick S. Greene, Superintendent of Public Works of the state, doubts whether any other state in the union has more signs than this upon its highway system.

Under the law, the Highway Department is not permitted to erect a sign inside the limits of any city. However, most of the up-state cities have co-operated with the department and have marked the route numbers on the telegraph and trolley poles along their streets followed by through routes.

Albany Water Supply Contract

The Board of Water Supply of the city of Albany has awarded a contract for the Alcove Dam project, bids for which were received on July 9, to Winston & Company, Inc., of Kingston, N. Y. This dam will be a part of the new water supply for the city. It will be of core wall construction and will be used to impound approximately 12 billion gallons of water from the Hannacroix Creek. The bid of the successful contractor was $742,449. The highest bid was $1,007,654. Work has already been commenced on the above contract, the schedule calling for its completion by June 1, 1930.

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CONTENTS

Some Notable Features in Water Works Construction

The development of the Little River supply of the Springfield Water Works, described in this issue, contains much of interest to engineers. Perhaps the structure of greatest interest is the Cobble Mountain Dam. Since the failure of the St. Francis dam last year, public as well as engineering interest is aroused by the construction of high dams. The Cobble Mountain dam, 245 feet above its foundations, is to be the highest earth dam in the world. Its claim to this title merits its careful study by engineers.

A well-built earth dam is probably the safest type of dam, though it has its weaknesses. Overtopping is especially dangerous, as is the damage by heavy overflows; but these are well guarded against in the Cobble Mountain dam, where a natural spillway of solid rock a considerable distance from the dam site with a capacity greatly in excess of record flows discharges the overflow a half mile downstream from the toe of the dam. An impervious core, and proper down-stream drainage, are necessary. These are provided by the design and method of construction, described briefly in the accompanying article. The canyon or gulch in which the dam is placed is of rock; but the possible planes of weakness resulting are eliminated by cut-off walls and other devices.

Other features of interest include the use of welded steel pipe of large size, which is rather unusual in the East. Advantages secured by the reduction of the number of joints and less first cost undoubtedly justified the choice. Steel pipe possesses good hydraulic properties and when properly protected is durable.

The construction should develop features of as great interest as the design. Construction of the dam has not yet begun. As with most dams, construction will be subject to the hazards of high water, and it is interesting to note that the city assumes responsibility for damage due to extraordinary floods up to May 1, 1929. Heavy rains which occurred in this section of New England just as this issue of PUBLIC WORKS went to press, raised the level of the Westfield River, into which Little River flows 5 feet, but no reports have been received regarding damage to the cofferdam.

Effect of Trade Wastes on Sewage Treatment

During the past few years American engineers have begun to realize the importance of trade wastes in sewage. A few have given special attention to the matter for a number of years, but the majority have until quite recently either failed to consider them at all or thought of them as extraneous matters which may interfere with the treatment of sanitary sewage and should be excluded if possible.

In this issue Prof. Rudolfs compares results obtained with Imhoff tanks in this country and in Germany and suggests that the more satisfactory operation almost universally found in the latter may be due to the beneficial effects of certain trade wastes, especially those from iron works and coal mines. Comparisons of the operation of plants in this country made during the past four or five years have paid great attention to detail of their construc-

tion and operation, but not so much, as we recall, to the composition of the sewage itself. Knowing as we now do the effect upon digestion of relatively small amounts of acids and alkalis in sewage, and the almost infinite combinations possible between varying amounts of the many kinds of trade wastes that reach our sewers, it would seem to be highly desirable that a more thorough study be made of these and of the effects of various combinations of them upon the sedimentation and digestion of sanitary sewage.

North Bergen Sewage Plant

A sewage treatment plant has been completed in North Bergen Township, Hudson County, N. J., as the result of a mandatory writ of injunction restraining the township from polluting the waters of the Hackensack river and tributaries, obtained from the State Department of Health in 1921. Because of the increasing density of population in that section of the state, the plant includes glass-covered sludge drying beds and settling tanks. The glass covering for the sludge drying beds is the ordinary hot-house type, while the covering for the tanks consists of vertical walls more than three-fourths of the area of which is composed of glass. This is the third plant in New Jersey to adopt the glass covering of sludge beds.

Sewage Treatment Abroad[1]

Comparisons of results obtained with American plants and with the European plants described in previous articles of this series. Effect of designing, operation, character of sewage and climate and other local conditions.

By Willem Rudolfs[2]

In comparing German sewage treatment practice with that followed in America there are several questions which arise. Any one who has seen a number of disposal plants in the Ruhr district is impressed by the fact that troubles so often encountered in this country seem to be absent there. There may be three reasons for the difference: (1)-design of the plants is more perfect in Germany; (2)-operation of the plants is better; and (3)-character of the material to be treated and general conditions are different.

DESIGN

The best example to be taken is afforded by Imhoff tanks. There are a comparatively large number in the Ruhr district and also in this country. A variety of designs exist in both countries. Improvements made during the course of years have been copied. Some plants in this country are almost exact duplicates of some plants found abroad. Nevertheless, the plant might work satisfactorily in Germany and cause all kinds of troubles here. Obviously it is not the type of design which is responsible for the differences in behavior.

OPERATION

Organizations like the Ruhrverband, Emschergenossenschaft, Lippegebiet, etc., are formed for the protection of certain streams and water courses. The cities and towns in the districts are taxed and disposal plants built where necessary. These organizations have full control of the design, construction and operation of any plant in their district. The result is that a small group of experts can apply new methods and improvements of existing plants every time an opportunity is offered. Theoretically at least, the operation of the plants is under the supervision of these same experts. The actual operation of the plants is handled in the great majority of cases by operators who have come up from the ranks. These operators conduct regularly simple tests like percentage settleable solids removed by Imhoff cones, pH values, etc. Once or twice a year a sample of the material treated as analyzed at a central laboratory and the plants occasionally visited by the organization engineers. Whenever experiments are conducted they are performed by the chemists and engineers of the organization. Ordinarily the every day operator is left much alone to carry out his instructions. Some of the metropolitan sanitary organizations in this country are functioning much the same way, but have as a rule closer control of the operation. It would be possible, however, that a more or less uniform control of all disposal systems in a district was responsible for the good results abroad, if there were no trained operators at similar plants in this country.

Examples could be given, however, where competent, conscientious, well trained chemists or sanitary engineers are continuously on the job in this country and still the results obtained cannot be compared with those accomplished in the Ruhr district. While there is no doubt that the best built plant might produce poor results when careful and efficient operation is lacking, and that a sewage plant operator must be trained in his art to produce best results; it would seem that the differences in results observed cannot always be attributed to inadequacy in operation in this country.

GENERAL CONDITIONS

For the sake of simplicity in discussion, the character of material to be handled and the general conditions which might possibly influence the behavior of the disposal plants are divided into two groups: (1) climatic conditions and water supply, and (2) character of sewage.

Climatic Conditions.—General climatic conditions in the whole Ruhr district and also in Holland are fairly uniform. The annual rainfall varies from 25 to 30 inches. The average daily winter temperature of the air at Essen-Rellinghausen[3] fluctuated in 1925 from 38° to 42° and during the summer months from 64° to 71°F. The average temperature at Utrecht,[4] the center of Holland, was for 1926 from 36° to 41°, and during the summer from 58° to 68°F., with an average yearly temperature of 48.5°F. These extreme temperatures lasted only for a very short time. The extreme temperatures recorded in Holland were 16° and 87°F. No extreme variation figures are available for the Ruhr district, but it is

[1]Paper No. 76, Department of Sewage Disposal, Agricultural Experiment Station, New Brunswick, N. J.
[2]Chief, Dept. Sewage Disposal.

[3]Imhoff, Fries and Sierp. Tech. Gemeindebl. June 1927.
[4]Report Meteriol Inst. 1927.

probable that they are not far from those recorded for Holland.

Although the air temperature, with its variations, is not a great factor under San Francisco climatic conditions it may be of more importance in the North and South.

Water Supply.—The water supply in the Ruhr district comes from the various rivers which are protected by the disposal plants from gross pollution. Most of the water used comes from the Ruhr valley and is for instance pumped into the Emscher and Lippe districts. The daily per capita consumption of water in cities with average industries is in Germany (according to Bruns[5]) from 20 to 26 gallons. The water consumption in the Ruhr district is from 120 to 160 gallons per capita, due to the large industrial consumption. The sewage flow at Essen-Rellinghausen is 150 gallons per person. The water is for all practical purposes surface water, which is filtered in so-called "Sickerbecken" found ordinarily about 50 yards from the stream. Brun estimates that about 90 per cent. of all water in the Ruhr valley is filtered stream water. Analyses of the water in Essen show the following:[6]

Total solids	210 ppm.
Ash	170 "
Cl	35.5 "
Free CO_2	19.4 "
O_2	4.2 cc. per liter
Fe	0.07 ppm.
Total hardness	6.7°

The composition of the water does not differ much from that found in a number of places in this country and it is doubtful that the water as a carrie of the sewage is responsible for great differences in behavior of Imhoff tanks in this country and abroad. There are great differences in the water supplies in the United States and still troubles may occur independently.

CHARACTERISTIC OF SEWAGE

The characteristics of the sewage in the Ruhr district might conveniently be divided into (1) strength of sewage, (2) temperature, (3) freshness, (4) trade wastes and (5) combined systems.

Strength of sewage—The strength of the sewage in the Ruhr district, so far as suspended solids is concerned, is in general comparable to that in the United States. This is very well illustrated in the

[5]Bruns, Kleine Mitteilungen, 5, 1927.
[6]Nerreter, Kleine Mitteilungen, 5, 1927.

TABLE I.—Strength of Sewage of a Number of German and American Cities—Analyses Taken From Various Published and Unpublished Reports.

Place	Sample taken	Year	Suspended solids ppm.
Essen-Rellinghausen	24 hours	1927	180
Hagen, Germany	catch	"	194
Langendreer, Germany	"	"	201
Iserlohn, Germany	"	"	481
Hartford, Wisc.	hourly for 1 week	"	267
Antigo, Wisc.	" " "	"	152
Ridgewood, N. J.	" " "	"	138
Sioux Falls, S. D.	" " "	"	227
Plainfield, N. J.	average for year	"	225
Rochester, N. Y.	" " "	"	274
Worcester, Mass.	" " "	1926	278
Schenectady, N. Y.	" " "	"	167
Marion, Ohio	" " "	"	271
Baltimore, Md.	" " "	1925	571

table No. 1. Iserlohn, Germany, showed in catch sample 481 ppm. suspended solids. This plant treats the sewage of 17,000 people with a flow of about 45 gallons per capita. Some industrial waste fron small metal factories and furnaces is received. A considerable distance in front of the three Imhoff tanks is a "rain water basin" used for equalizing the flow and which catches large quantities of grit and considerable amounts of organic matter.

As a rule the per capita flow is less than in the U. S. A few examples show this. The flow in gallons per capita at several cities is:

Essen-Rellinghausen	150	Wetter	35
Werden	50	Menden	40
Velbert	50	Steele	150
Diusburg	135	Dahlhausen	46
Hagen	82	Langendreer	87
Iserlohn	45	Kettwig	72

Sewage temperature.—Variations and averages of sewage temperature are of greater interest than air temperatures. In table 2 some data are presented collected during the last few years.

TABLE 2.—Minimum, Maximum and Average Temperature of Sewage (°F).

Place	Min.	Max.	Aver.
Chicago (Calumet)	41	69	53
Milwaukee, Wisc.	42	69	54
Antigo, Wisc.	47	65	54
Schenectady, N. Y.	47	67	55
Rochester, N. Y. (Brighton)	45	61	55
Waco, Texas	..	..	70
Plainfield, N. J.	48	74	59
Indianapolis	42	81	66
Essen-Rellinghausen	53	66	59
Bochum, Germany*	..	..	61
Essen, Germany*	..	..	65

*Imhoff, Tech. Gem

Unfortunately minimum and maximum figures are available for only one of the three cities in the Ruhr district, but since the yearly averages of the other two are higher and both cities are in the highly industrialized centre with much warm trade waste, it is fair to assume that the fluctuations will not be much greater than for Essen-Rellinghausen.

A glance at the table will show that the minimum temperature of the sewage in cities in the East and Middle West (with far greater atmospheric temperature fluctuations) is in every instance below that of Essen-Rellinghausen. This could possibly furnish a clue. But it also will be noticed that the average temperature at Plainfield, N. J., is like that of Essen-Rellinghausen. The variation in temperature, however, is far greater at the former than at the latter place. Knowing that in Imhoff tanks the temperature of the sludge follows the temperature of the sewage rather closely, the maximum difference of 5°F during the winter months may be a factor, but it is very doubtful that it would explain the difference in behavior of the Imhoff plants at these places.

Digestion capacity—Those Imhoff tanks which are not giving trouble in this country seem to have ample sludge digestion capacity. What is the practice in Germany? Imhoff[7] concludes that in Germany when the sludge compartment is well utilized the requirements are 1.0 cubic foot per capita. One of the newest plants built in the Ruhr under the direction of Imhoff for the town of Kettwig and receiving

[7]Tech. Gem.

large quantities of wool scouring waste has 1.8 cu. ft. digestion capacity per connected person.[8] Eddy in his paper "Imhoff tanks—Reasons for Differences in Behavior"[9] states that the gross capacity at Rochester was 2.49 cu. ft., Schenectady 1.40 cu. ft. and Plainfield 1.49 cu. ft., all of them more than the requirements set by Imhoff, yet two of the plants have had no end of trouble. As Eddy points out in his paper, the character of the sewage is an important item in calculating digestion capacities.

Combined systems.—There is a great difference between the sewage disposal systems in the Ruhr district and the majority of places in the U. S. Abroad all the systems are combined, whereas the majority in this country are separate systems.

Trade wastes.—It is well-known that certain trade wastes are detrimental to the operation of a sewage disposal plant. We are just learning through the collection of data and experimentation that certain trade wastes may be highly beneficial. All plants in the Ruhr district receive larger or smaller quantities of trade wastes, particularly iron and coal mine wastes. The visitor is struck by the fact that the raw sewage is gray-black in color as compared with the milky color of domestic sewages received at plants in this country. As soon as certain trade wastes are received at plants in this country the color changes and is more comparable to the German sewage.

Although the amounts of suspended solids per capita are comparable, the story becomes different when the solids deposited are analyzed for volatile matter content and ash. A few examples will illustrate this point. The percentages of organic matter in the fresh solids and ripe sludge are:

	Fresh Solids	Ripe Sludge
Rellinghausen	55	45
Plainfield (Domestic)	78	48-50
Baltimore (mainly domestic)	73	45
Trenton (trade waste)	55	40
Philadelphia (trade waste)	50-52	36-40

The volatile matter content of the fresh solids at Rellinghausen is 55 per cent., which is the same as that at Trenton. At Trenton considerable quantities of "pickling liquors" and other trade wastes are received. On the other hand, domestic sewages like those at Baltimore and Plainfield contain about 40 per cent. more volatile matter. During the digestion processes the volatile matter content at Baltimore was reduced to the same percentage as the material treated at Rellinghausen. It is evident that the more volatile matter there is, the longer the digestion period; and if, for the sake of argument, the same digestion capacities were employed, Baltimore would have far more chance for troubles. Baltimore and Plainfield sewage sludges are not different from sludges at other plants where domestic sewage is treated, but they are incomparable with sewage sludge at plants where trade wastes are received.

During the last three years we have been experimenting with sludges from different plants where trade wastes are received. One among them is material from Trenton. The results will be published in due time, but it is of interest here to state that unseeded Trenton fresh solids digest in a fraction of the time required for domestic sewage sludge. If seeded properly, these solids digest in little more than half the time required for domestic solids received at Plainfield and Baltimore. The main reason for the difference appears to be the quantities of iron received at the Trenton plant. Since the iron industry is very important in the Ruhr district, results obtained there might not be applicable to domestic sewage treatment plants here. A number of plants in the Ruhr district receive also mine drainage water. This drainage water contains considerable amounts of coal and slate dust in addition to chlorides and sulfates. What is the effect of this waste upon the settling and subsequent digestion of domestic sewage solids? A question which should be answered before results can be interpreted into American practice.

Freshness of sewage—One of the imperative essentials to sanitary sewerage is, as Folwell[10] states, "That all of the sewage be removed without delay to a point where it may be disposed of." The reason is obvious. Sewage which has traveled but a short distance in sewers is still "fresh" and contains free oxygen, while sewage carried for several hours in sewers is depleted of oxygen and becomes "stale." The staler the sewage the more difficult to treat. Keeping the sewage fresh is an important problem and is practiced in Germany on a large scale. Nearly all sewage is collected and then transported in open concrete or brick troughs or ditches to the plant. Some of these ditches are several miles long and the sewage reaches the plants in a condition rarely obtained in this country. For instance, the sewage at Hagen averaged in a number of samples 4.5 ppm. O_2 at 10° C, and that at Rellinghausen varies from 4 to 6.5 ppm. oxygen. There is no doubt that the German practice of keeping the sewage fresh is of help to subsequent treatment. This can be done where variations in climatic conditions are not great; it is doubtful, however, whether such practice could be followed in this country with its extreme variations in temperature.

DISCUSSION

It should be understood that this article is not intended to discredit or criticize any method of sewage treatment originated abroad, but is merely an attempt to analyze and find reasons for differences in the results obtained when these methods are applied in this country. For, with the most careful duplication of design and construction, some of the methods have given troubles. The example of Imhoff tanks has been taken because of the large number of plants of this type in this country. Almost without exception these plants work to complete satisfaction in the Ruhr district, although in other places in Germany they have caused troubles with foaming, etc. (see especially Gesundheits Ingenieur, No. 20, 1915, No. 32, 1918; Mitteilungen Landesanstalt fur Wasserhygiene No. 18, etc.). Why do these plants work to perfection in the Ruhr district and cause troubles in a number of other places? If it is a question of manipulation, German methods should be followed. If it is a question of fundamental differences in the material to be treated or the general climatic conditions, methods worked out in Ger-

[8] Mahr, Tech. Gem. April 5, 1928.
[9] Eddy et al Proc. Am. Soc. 50, p. 616, etc.
[10] Folwell, Sewerage, Wiley and Sons.

many cannot be taken over without scrutiny and thorough experimentation under the different conditions.

It could be assumed that the atmospheric condition or the temperature of the sewage was all important, but we have the examples of Rochester in a fairly Northern climate where Imhoff tanks perform well, and the plant at Fort Worth, Texas, in the South, where the same type of a plant has caused considerable trouble. Both these disposal systems have been and are under supervision of highly trained chemists and engineers.

From the brief discussion under the heading "Digestion Capacity," it is evident that German practice is not applicable to at least certain places in this country. The reasons for differences in behavior must, therefore, be sought elsewhere. It seems to me that the three most important factors are:

First, the low volatile matter content of the sewage in the Ruhr district. The reduction in volatile matter from the fresh solids to ripe sludge is only 18 per cent. at Rellinghausen, whereas no ripe sludge can be produced at Plainfield with less than 50 per cent. volatile matter reduction. The amounts of suspended solids received at Plainfield are greater than at Rellinghausen and on top of that, for each pound dry volatile matter decomposed at Rellinghausen not less than 2½ pounds must be decomposed at Plainfield. The same holds for Baltimore and other places where domestic sewage is treated.

Second, the type of trade waste received in a number of German plants aids in settling and decomposition.

Third, the German sewage is of a freshness which can but rarely be obtained in this country.

These differences are such that results obtained in Germany are not applicable to all conditions in this country and certainly not when domestic sewage only is treated. It would seem wise, therefore, if new methods are evolved abroad, in either Germany, Holland or elsewhere, that they be scrutinized and thoroughly tried out in this country by our engineers before they are utilized on a large scale.

Contact Aerator at Rochester, New York

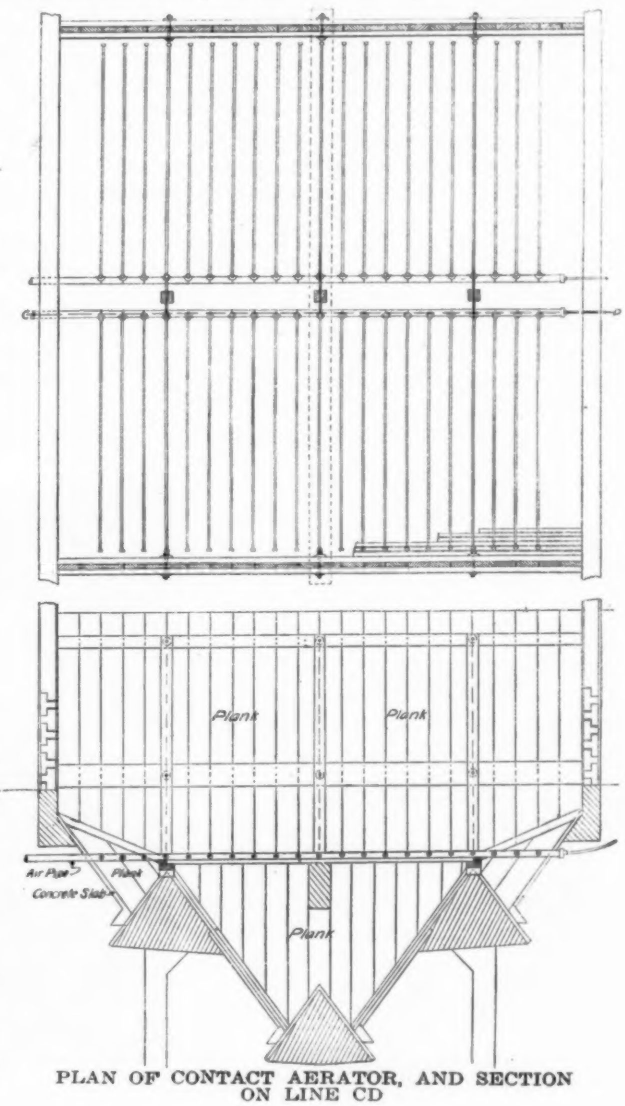
Constructed with a view to increasing capacity of existing sprinkling filter by partially oxidizing sewage in tank

At the Brighton sewage disposal plant of Rochester, New York, an Imhoff tank and two half-acre units of sprinkling filter have been in operation since March 1, 1916. These were approaching the limit of their capacity and it was decided to construct a second Imhoff tank similar to the first and symmetrical with it about the axis of the plant. To construct another acre of sprinkling filters 6 feet deep would cost over $100,000 and it seemed probable to John F. Skinner, sanitary engineer of the Department of Public Works, that if a contact aerator be built in this tank it would effect such oxidation of the sewage that it would be possible for a number of years yet to get along with the original one acre of filter area. If, after experience with the operation of this contact aerator, it is found to perform as anticipated, it is possible that another will be placed in the original Imhoff tank.

As the old Imhoff tank has been in operation continuously since 1916, when the new tank has been placed in operation and thoroughly seeded it is proposed to dewater the old tank, make some minor repairs, and possibly install a contact aerator therein also.

The installation of the first aerator was completed in the latter part of July and it was put into operation early in August of this year.

The settling chamber of the new Imhoff tank is 62½ feet long and 24 feet wide, the ends of the tank being rounded to a 15 foot radius. The contact aerator has been constructed by building a bottom and two partitions of wood the latter 24 feet apart and extending the full width of the chamber, thus making the tank 24 feet square with a maximum depth over most of the floor of 11 feet, with two sides sloping to a minimum depth at the side wall of 9 feet. The bottom of this inner tank consists of planed 2 by 4 pine set on edge with ¾″ slots between. The air pipe system consists of two headers which can be operated individually, and lateral dis-



PLAN OF CONTACT AERATOR, AND SECTION ON LINE CD

tributors of ½" copper service pipe placed at one foot intervals with two ⅛" holes at one foot intervals on the lower quarters of the laterals. The tank was filled with coke to within a fraction of a foot of the top, the coke being of nut size, which corresponds closely to the stone used in the trickling filter, which averages one inch (weight of individual stones corresponding to spheres of the material one inch in diameter). Above the stone, a galvanized steel wire mesh one inch square was laid and covered with two-inch broken lime stone, the object of which is to prevent the choke from floating, which it shows a tendency to do. The coke used was supplied by the Donner Steel Company after comparison with other cokes, this appearing to be the most uniform and dense and with least cracks and fractures.

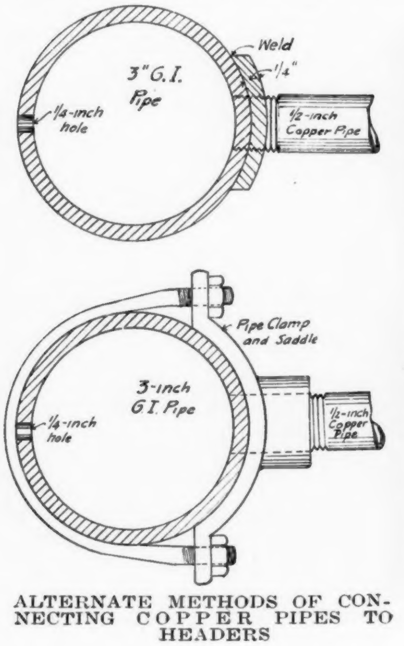
In the sludge chamber of the Imhoff tank there is a center wall dividing it into two sections. This wall has been carried up as a wooden partition from the bottom slabs of the settling chamber to the bottom of the contact aerator, in order that all sewage which enters the tank will pass through the aerator.

Under ordinary operating conditions there will be about an hour's detention in the first portion of the tank, after which the sewage will rise through the slotted bottom and the coke, while air is blown through the aerating pipes. It will then flow over and partially through the down-stream side of the coke filter, overflowing into the second portion of the tank, where there will be a period of settlement equal to that in the first portion.

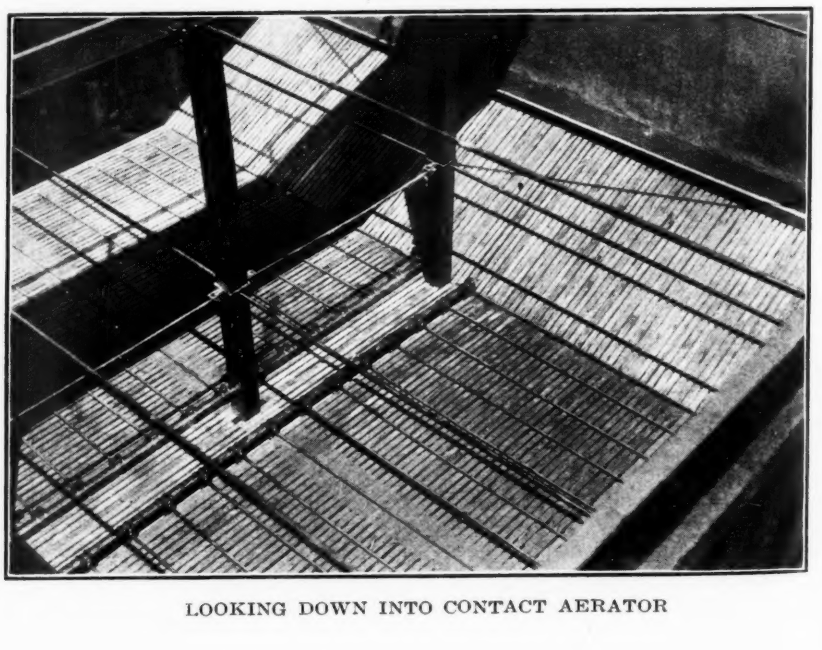
The air is supplied by two No. 2 Nash Hytor compresors mounted in line on a common base with two clutches leading to a common pulley in the center. This pulley is the smaller pulley of a five-fold Tex rope drive from a 36-inch wheel which is actuated by the sewage which reaches the operating house under about 70 feet head from the screen house on the hill above. It is intended to use one compressor ordinarily, and when a larger quantity of sewage is coming and more power is available, to use both compressors if found necessary. This can readily be accomplished by throwing in one or both of the clutches and thus operating one or both of the compressors from the common drive. Each compressor is rated at 181 cubic feet of air per minute under 6 pound presure and requires 9.4 horse power at 680 r. p. m. The amount of power required for one compressor is available at all times. A Pelton wheel of less capacity was originally installed at the plant and is still in operation. This is belted by a short Tex rope drive to a 6.5 k. w. generator which furnishes a small amount of power and operates lights about the plant. It is computed that with three-fourths of this electric load, which easily furnishes all of the lighting, the sewage flow at the rate of 1,750,000 gallons per day will operate one compressor and the lighting system at night. When the generator is not running, two compressors may be operated by a flow of a little over 2,000,000 gallons per day, and 3,000,000 will operate both compressors and the generator. The quantity of sewage is increasing in the territory and will soon reach these limits at times.

The amount of air so available is very much larger than has been used in contact aerators. It is the hope of Mr. Skinner that with this surplus they will be able to make experiments and fix, for this particular sewage, the amount of air required for a given effect so that useful data may be furnished to plants proposing to adopt the system where the compression of air will be a matter of expense.

Some engineers who have operated experimental plants have offered the suggestion that the coke in this plant will clog readily with solids from the partially settled sewage. The Rochester engineers expect that, with the larger amount of air available, they will be able to drive a mixture of air and sewage through the bed without cloging. The plant is so arranged that it is possible to readily reverse the flow of sewage and also to furnish air to the opposite or up-stream side of the aerator. It will thus be possible to wash the filters with upward flowing air and clarified sewage, much as is done in washing a mechanical filter used in water works plants.



ALTERNATE METHODS OF CONNECTING COPPER PIPES TO HEADERS



LOOKING DOWN INTO CONTACT AERATOR

Recent Legal Decisions

FUNDS VOTED FOR WATER MAIN ON SPECIFIED STREET HELD NOT AVAILABLE TO PAY FOR MAIN ON ANOTHER STREET

The Washington Supreme Court holds, George v. City of Anacortes, 265 Pac. 477, that the use of funds voted to construct a water main to cost $5,700 on a specified street to pay for a main on another street is not an incidental change of location, where the whole project approved cost less than $50,000, and might be enjoined. The court thought that, an item as large as this being specifically set out, it would violate the spirit of the statute, authorizing the adoption by vote of a plan specified by the authorities, to require its approval of the voters and then permit it to be changed at the caprice of the city's officers.

INJUNCTION OF RATES PENDING REVIEW OF COMMISSION'S ORDER IMPOSING THEM REFUSED

The Wisconsin Railroad Commission having made an order fixing the compensation to be paid by North Milwaukee to Milwaukee for water for its distribution system at 10 cents per 100 cubic feet instead of 6 cents as theretofore, and another order readjusting the rates to consumers in North Milwaukee, a consumer applied for injunction pending action to review the second order, restraining enforcement of the rates prescribed thereby, on the ground that the first order is void, and that in any event Milwaukee will continue to supply water at the 6 cent rate until January 1, 1930.

The Wisconsin Supreme Court, J. Greenbaum Tanning Co. v. Railroad Commission, 217 N. W. 282, pointed out that the question whether the first order is void was not before it, and the second order is valid until set aside in the manner prescribed by statute, whether the first order is valid or not. Whether a temporary injunction should issue was largely within the discretion of the trial court, and since the only inconveniece its denial would cause the consumer would be having to pay the prescribed rate under protest, which would be refunded if found unlawful, while, if the second order is found valid, the city of North Milwaukee could be deprived of its additional revenue, or at least it would be rendered very difficult of collection, it was held that the trial court did not abuse its discretion in denying the temporary injunction.

DISPOSITION OF PURCHASE PRICE OF WATER PLANT SOLD BY DISTRICT

The Arkansas Legislature of 1923 having passed an act authorizing the sale of waterworks, gas, or electric plants operated by municipal corporations, or improvement districts, a water district sold its plant to a private corporation for cash and the assumption of outstanding bonds of the district. The district had purchased a small part of the plant from a district which had formed a small part of the new district, for a sum which was paid by allowing the property owners in the old district a set off in the assessment of benefits. It was held, Ogan v. Jackson, Arkansas Supreme Court, 300 S. W. 446, that the profits in the hands of the new district and the purchase price of the plant fell to be distributed equally among the landowners of the old and new district.

WATERWORKS CONTRACTOR'S CONVEYANCE OF EQUIPMENT, ETC., TO SURETY HELD INVALID

The Illinois Appellate Court holds, Southern Surety Co. v. Peoples State Bank of Astoria, 243 Ill. App. 195, that an agreement by contractors for the construction of a waterworks system conveying to the surety on their bond for completion the tools, plant, equipment and materials on the work, money due or to become due to them under their contract, and their rights in all subcontracts, as collateral security, with power of attorney, to take possession in case of their default, was in violation of the Illinois Bulk Sales Law as to other creditors and did not have the effect of a chattel mortgage.

LEVY OF TAX TO PAY SEWER CONTRACTORS

The Utah Supreme Court holds, Ryberg v. Lundstrom, 261 Pac. 453, that a city which had agreed to issue warrants to contractors for the construction of a sewer was liable for their payment under Utah Comp. Laws 1917, Secs. 699 and 748, as amended in 1921, if the levy of the tax was illegal under Sec. 683, as amended, and that, as part of the assessments had been paid, it would result in confusion to compel a new levy to be paid, and no injustice or harm could result to the contractors by the denial of their request for a writ of mandamus to require an additional levy.

WATER RATES—APARTMENT HOUSE HELD ONE HOUSE

The Kentucky Court of Appeals, in Maysville Water Co. v. Stockton, 221 Ky. 610, 299 S. W. 582, holds that an apartment house containing 8 dwellings, is one house, used by eight families, and not eight dwelling houses," within the schedule to an ordinance imposing water rates, which imposed rates for "Dwelling houses." The apartment house had been supplied by the company with water at meter rates for 11 years under an agreement with the owner who paid as a single consumer. This fact would not have given the owner a right to the continuance of the meter rate, if it was not warranted by the ordinance. The court held, however, that the apartment building was a structure not named in the ordinance and not within the contemplation of the parties in any of the specifications of the ordinance, and was therefore governed by the meter rates.

The court distinguished the case of Berends v. Bellevue Water Co., 119 Ky. 8,82 S. W. 983, which was a case of six tenements, each with an outer door to the street, and with no communication with each other, although all were covered with a common roof. In this case none of the apartments had an outer door, and the halls, stairways, hot water service and laundry were all used by the tenants in common.

CITY'S RIGHT TO RESTRAIN POLLUTION OF DRINKING WATER

Can a public swimming pool for commercial purposes be established on a river or lake and be used by hundreds and thousands of people so that the use

pollutes the water and makes it unfit for drinking and domestic purposes, and so unsafe for use by the riparian owners or those who have legally appropriated the water below the bathhouse or swimming pool? The Texas Court of Civil Appeals, in Newton v. City of Groesbeck, 299 S. W. 518, answered this question in the negative. The suit was one for injunction by a city which had legally appropriated the water of a river for drinking and domestic use.

The courts uniformly hold that a city has the right to restrain the pollution of its drinking water. Moreover, the Texas Legislature, Rev. Stat. article 4,444, specifically provides that no one has a right to pollute any water course or other public body of water which is being used for drinking and domestic purposes.

The fact that the river may have been in the past occasionally used for bathing purposes by the riparian owners or others would not give any one the right to establish a bathhouse and commercialize the water impounded by the city for drinking and domestic purposes to the extent that the water would thereby become polluted and unfit or unsafe for use.

EXTENSION OF SERVICES BY WATER COMPANIES

A partnership is required to render adequate service within the territory supplied by it to the same extent as a corporation; but no public service company is required to expend money in the construction of facilities if there is no reasonable demand for the service to be rendered through such construction.

So a water utility was not required to extend its pipes to serve nine residents of a borough, where the returns on the investment, after deducting depreciation, would be about 4.55 per cent., in view of the limited demand and the inadequate return.—Rockhill v. Fraker & Bush, Pennsylvania Public Service Commission.

A water company was not required to extend service to five prospective consumers where the cost of installing and operating the service asked for would have to be largely absorbed by other patrons of the company to enable the company to receive any reasonable return on the money invested and required for rendering the service.—Culp v. Roaring Creek Water Co., Pennsylvania Public Service Commission.

MUNICIPALITY MAY, UNDER TENNESEE ACT, RECOVER MONEY PAID TO OFFICER INTERESTED IN PUBLIC CONTRACT

The Tennesse Supreme Court holds, Savage v. Mynatt, 299 S. W. 1043, that where city officers were interested in a public contract and received compensation therefor, the city, under Shannon's Code Secs. 1133-1135, making it unlawful for an officer to be interested therein and providing that any such person "shall forfeit all pay and compensation therefor," could not only refuse payment to such officers, but could recover back any compensation which had been paid to them against the prohibition of the statute.

MAINTENANCE OF AIRPORTS BY CERTAIN CITIES AUTHORIZED BY KANSAS STATUTES

The Kansas Supreme Court holds, City of Wichita, v. Clapp, 263 Pac. 12, that the devotion of a reasonable portion of a public park to an airport, for recreation and other attendant purposes, comes within the proper and legitimate uses for which public parks are created. Kansas Laws 1927, c. 117, authorize the board of park commissioners of cities of the first class having a population between 80,000 and 110,000 to acquire public parks within five miles of the corporate limits of such cities, a reasonable portion of which may be used for airports. Rev. Stat. 1923, 3—110 is comprehensive enough to enable a city to maintain out of general funds such an airport, the park containing which has been securred under the 1927 act.

MUNICIPALITY'S OFFICER CANNOT HAVE INTEREST IN PUBLIC CONTRACT

The Pennsylvania Supreme Court holds, Commonwealth v. Gardner, 291 Pa. 98, 139 Atl. 626, that a borough councilman who accepts and performs labor for pay, whether as an agent or an employee, under a contract for borough work, has an interest in such contract and violates Pa. Act May 28, 1907, so as to authorize his ouster from office by quo warranto proceedings, whether or not he acted with fraudulent intent.

APPLICATION OF PENNSYLVANIA PLUMBING CODE

The Pennsylvania Supreme Court holds, City of New Castle v. Withers, 291 Pa. 216, 139 Atl. 860, that the Pensylvania Plumbing Code is not unconstitutional as violating the federal Fourteenth Amendment or as being an unwarranted exercise of the police power. Under it equity has jurisdiction to require the removal of plumbing not conforming to the statute. Although, because a city has a sewage system differing in construction from other cities of the commonwealth, some of the provisions of the act cannot be applied in it, that does not make those provisions of the act inapplicable which fit its situation. The suit was in equity to require the owner of an apartment house to make certain changes in the plumbing so that it would conform to the requirements of the act.

SLIGHT VARIATIONS FROM SEWER SPECIFICATIONS BENEFICIAL TO OWNER WILL NOT INVALIDATE ASSESSMENT

Specifications for sewer construction required that certain house branches or connections after installation be "plugged and capped." The California Supreme Court holds, Noyes vs. Chambers & De Golyer, 261 Pac. 1006, that property owners cannot, in a suit to quiet title to their lots, collaterally attack the assessment imposed therefor on the ground that the house branches were plugged and capped only at one end, the other end having been connected with sewers constructed by the city, where the variation resulted in a benefit to them rather than a detriment, and they had failed to appeal to the city council within 30 days from the issuance of the warrant for the work, as required by the statute.

OVERFLOW FROM SEPTIC TANK AND SEWER

The maintenance of a nuisance by permitting the overflow from a septic tank to flow into a ditch and over and upon the lands of an abutting owner may, the Oklahoma Supreme Court holds, be enjoined.—Town of Jennings v. Pappenfuss, 263 Pac. 456. And where a city, without an owner's consent, puts in a sewer which empties out upon his land, the owner is held entitled to compensation for the damages sustained by reason of the public use of his property.—Page v. Oklahoma City, 263 Pac. 448.

NEW CATALOGS

Monarch Tractors Corporation, Springfield, Ill. An illustrated folder describing the Monarch "75" tractor.

Kern Co., N. Y. A 12-page catalog describing Kern surveying instruments.

Kern Co., N. Y. "What the Engineer Should Know About Surveying Instruments."

R. Planche & Co., Villefranche-Sur-Saone, France. Illustrated folders describing rotary compressors and pumps.

Buckeye Machine Co., Lima, O. A 28-page illustrated folder describing Buckeye diesel type oil engines, 50 to 300 horsepower.

Truscon Steel Co., Youngstown, O. A 48-page catalog describing and illustrating Truscon copper alloy steel doors. Also gives specifications and drafting room standards.

Butler Bin Co., Waukesha, Wisc. Folder describing new Butler all-steel scale.

The Barrett Co., N. Y. A 32-page illustrated booklet describing the use of Tarvia for road construction and repair.

American Steam Pump Co., Battle Creek, Mich. A 12-page illustrated bulletin describing Barton fire pumps.

Truscon Steel Co., Youngstown, O. A new catalog, No. 126, describing Truscon continuous steel windows and mechanical operators. Discusses thoroughly efficient daylighting and controlled ventilation for industrial buildings.

Austin-Western Road Machinery Co., Chicago, Ill. An elaborate and valuable 44-page catalog describing Western Sand and Gravel, crushing, screening and material handling equipment; also a complete 48-page catalog covering Austin rock crushing equipment.

The Byers Machine Company has just issued two new catalogs, one on the Byers Master Shovel, 1¼ cu. yd. gas, the other on Byers Revolving Bear Cat, a ⅝ cu. yd. full revolving gas shovel. Both of these catalogs contain complete descriptions with mechanical working views and general specifications.

George Haiss Manufacturing Co., Inc., N. Y. A 24-page illustrated catalog (No. 1127) describing Haiss portable conveyors, with suggestions for use; Catalog No. 425, 20 pages illustrating and describing Haiss buckets for excavating and rehandling; Catalog 527, describing Haiss loaders and snow handling equipment, 32 pages; contains valuable data on estimates and cost, and on handling concrete aggregates; Catalog 623, 40 pages, describing Haiss material handling equipment.

Galion Iron Works & Mfg. Co., Galion, O., a 32-page catalog describing briefly the complete Galion line of large and small rollers, motor and drawn graders, both leaning wheel and straight wheel types, road drags, stone spreaders, belt conveyors and other equipment. Copy sent on request.

Sullivan Machinery Co., Chicago., Sullivan angle compound compressors of capacities from 300 to 5100 cubic feet of free air per minute are described in a new bulletin, No. 83-J. In addition to the general description of the Angle Compound machine, the bulletin, which is 6x9 inches in size, 32 pages, is featured by numerous illustrations of installations of these machines. Views are shown of the machine operated by direct connected Diesel engine, by short center belt drive from electric motor, by direct connected motor drive, in both single and twin units, including some units operated by magnetic clutches, and others equipped with stop and start control. The "Multi-step" system of load control, a distinctive feature of these machines, is described in this bulletin.

New Appliances

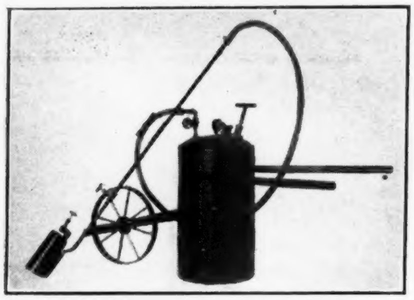
Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations

Chausse Wheelbarrow Oil Burner

The Chausse Oil Burner Company of Elkhart, Indiana, has announced an oil burner model arranged similarly to a wheelbarrow. This outfit can be easily transported by the man who requires it in his occupation and its use avoids the necessity for the employment of two men.

A conventional type welded steel tank with capacity of 14 gallons of kerosene is mounted in tubular steel shafts with a single wheel. To the tank, which has a self-contained air pump and pressure gauge, is attached the kerosene burner by means of heavy duty pneumatic tool hose. The burner handle is steel, with wooden grip and convenient needle valve.

This burner is self generating and produces a heat temperature from 1750 to 1800 degrees, F. The volume of gas is considerable and makes this outfit adaptable to such work as pre-heating prior to welding, thawing frozen piping, melting snow on tracks and switches, and wherever an intensely hot voluminous flame is desired.



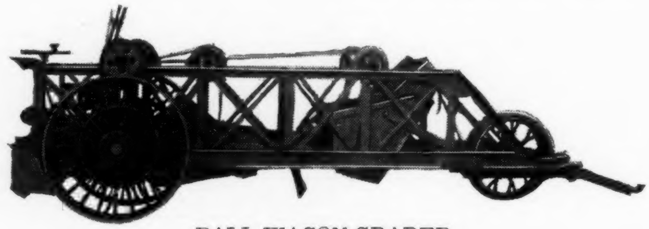
OIL BURNING WHEEL BARROW

Ball Wagon Grader

The Ball Wagon Grader Co., Stockton, Calif., manufactures the Ball wagon grader, which is a dirt-moving device designed to move dirt for short distances—from 50 to 1,500 feet. It is claimed that on the average dirt and grading job of 50 to 500 feet haul, a Ball wagon grader will do the work of approximately ten four-mule Fresnos, will work practically any place a Fresno will work, and work in some places and handle many kinds of soil that cannot be touched with a Fresno; and in comparison with a tractor drag scraper, the Ball wagon grader will move from three to five times as much dirt per day, using equivalent tractor power.

Two loading and carrying buckets of one cubic yard capacity, each, operate automatically from levers under the operator's hand. Each bucket is four feet in width and has a crucible plow steel cutting bitt which is easily removed for re-sharpening.

A seven-foot combination leveling and drag blade at the rear, behind the buckets, drags also one-half to one cubic yard of dirt and lifts and lowers by an easy-working hand wheel that limits the depth of spread. This regulating feature is of value in dam construction and highway and street work where spreading must be limited to very thin layers for rolling.



BALL WAGON GRADER

Once the dirt is in the bowl, power from a simple friction elevates the load while a specially designed self-locking apron, operating automatically, holds the dirt in place as the bucket is lifted. By means of the hand levers which operate the buckets, the operator, without leaving his seat, can shake the bowls to clean them of wet or sticky soil. There is no loss of dirt from the buckets on the road to the dump.

Power to raise, lower, fill and dump buckets is transmitted from the rear wheels by steel link chains which may be tightened or loosened on the friction drum.

The grader with tractor can be turned on a twelve-foot highway.

A "thirty" tractor will furnish ample power to operate the Ball wagon grader and where the haul justifies doing so, two graders in tandem can be handled by one tractor of this size. On approximately fifty per cent of the dirt moving conditions a "twenty" tractor will operate one grader.

An Improved Garbage and Ash Collection Truck

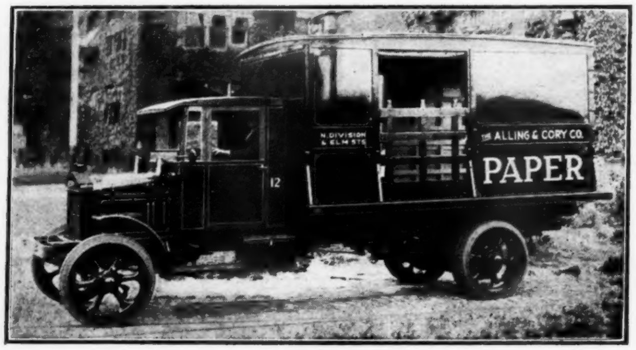
B. Nicoll & Co., general sales agents for the Collection Equipment Corporation, 292 Madison Avenue, New York, have developed the Colecto truck for garbage and ash collection. This can be loaded and dumped by one man and prevents any nuisance because of its special type of construction.

The truck is built either with a 10-cubic-yard or a 15-cubic-yard body made of No. 10 gauge steel. Refuse is loaded into a 10-foot bucket which is 20 inches high in front and 27 inches high in the rear and 22 inches wide. The bucket is raised by two cables at either end, equipped with equalizers, and runs on two tracks. It is raised by simply throwing a lever close by the forward end of the bucket. The bucket is then raised quickly to dumping position at the top of the truck, where it pushes back a steel apron and permits the refuse to fall into the body of the truck. When the bucket again drops to loading position, the apron swings forward and tightly closes the truck, preventing the escape of odors and dust.

The driving mechanism for dumping the bucket consists of a power take-off located usually on the left side of the

COLECTO TRUCK BEING LOADED

truck transmission. The lever in the cab makes it convenient for the operator to push it in or out of gear. By means of a chain and sprocket this operates a horizontal shaft which extends back to a universal joint just ahead of a small



PIERCE-ARROW MULTIPLE SPEED TRUCK

gear-box located near the body end. This arrangement permits the bucket to make a continuous series of round trips up and down without recourse to reverse gears and reverse mechanism. To stop the bucket at any point in its travel it is only necessary to throw the lever mentioned above.

For dumping, a hydraulic or mechanical underbody hoist is used with the power take-off on the right-hand side of the chassis, which elevates the body to a dumping angle of 45 degrees.

Pierce-Arrow Seven-Speed Heavy Duty Truck

The Pierce-Arrow Motor Car Co., Buffalo, N. Y., has announced the advance details of a new model H-B heavy duty unit with seven-speed transmission. The new model is claimed to have unusual flexibility of speed, gasoline economy and sturdiness. It will be manufactured in wheelbase lengths of 13 feet, 15 feet and 16 feet 6 inches. Under the Pierce-Arrow rating plan it has a vehicle gross weight of 20,000 pounds at the tires.

The power plant is a 4x5½ inch four-cylinder Pierce-Arrow dual-valve engine, developing 48 horse power, and embodying forced feed lubrication, automatically regulated Pierce-Arrow Stromberg carburetor, and oil purifier. The transmission gives seven speeds forward and two in reverse. It is claimed to solve completely two of the major problems of truck operation, i. e., hauling maximum loads over difficult roads, and speedy and economical operation when running light on smooth stretches.

This type of transmission produces the equivalent of two-four speed transmissions, one of them direct in fourth speed, and with a very low speed for unusual road and grade conditions. The other, direct in third speed with an overdrive in fourth is fitted especially for fast traveling.

The frame is of heat-treated chrome nickel pressed steel, 7 inches deep with a 3 inch flange width. Four heavy cross members are rigidly gusseted to the side members. The front axle is a heavy drop forged heat treated I beam with Elliott type knuckles. All levers are heat treated forgings and wheel bearings are of roller type.

The rear axle is the full floating worm drive type, with FJ type worm gear and case hardened worm supported in a cast steel carrier. Both radius rods and torque arm construction are used. The forged steel heat treated torque arm is swivel mounted at the rear with a ball and socket mounting at the end. The radius rods are tubular in construction with forged steel eyes at each end.

Two separate and distinct braking systems are installed on this model, the service brake being mounted on the propeller shaft at the rear end of the transmission and operating on a ten-inch brake drum. The hand brake is mounted on the rear axle, with two expanding shoes in each drum. An unusually large braking area is provided.

The gasoline feed system is pressure type, an automatic pump mounted on the crankcase and driven from the cam shaft supplying air pressure to the tank. An Alemite high pressure lubrication system is used for chassis lubrication. Wheels are cast steel, front and rear, taking 36x5 front and 36x6 rear solids and 38x7 front and 40x8 dual rear pneumatics. Road speeds from 16 to 24 miles an hour with a full capacity load can be maintained, depending upon the size of the tires and gear ratio.

Atlas Rotary Scrapers

The Atlas Scraper Co., Bell, Calif., manufactures the Atlas rotary-wheeled scraper, which, it is claimed, is extremely simple and rugged, and in operation is completely under control at all times. The load may be spread thin or dumped in a pile.

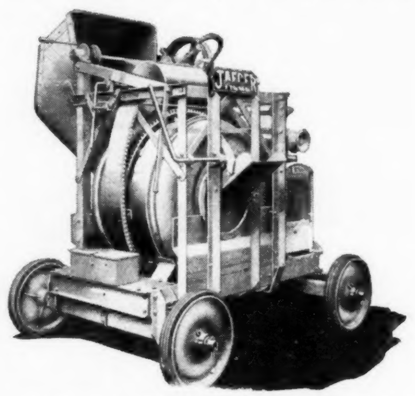
Atlas scrapers are made in various sizes and strengths, from 3 to 10 feet wide, and with capacities from 11 to 50 cubic feet. For the smaller scrapers, light tractors may be used; for the largest sizes, 60 to 100 h. p. tractors are required.

When riding either loaded or empty the weight is all on wheels; when spreading it slides on the shoes and in the load position only the wheels and blade are on the ground.

Jaeger Speed Queen

The Jaeger Machine Co., Columbus, O., has brought out the "Speed Queen," a 7-S non-tilt concrete mixer, mounted on four wheels and with a spring hung chassis. The mixing time and time for charging and discharge of this mixer are the same as the Speed King, a one bag trailer introduced by the Jaeger company a year ago.

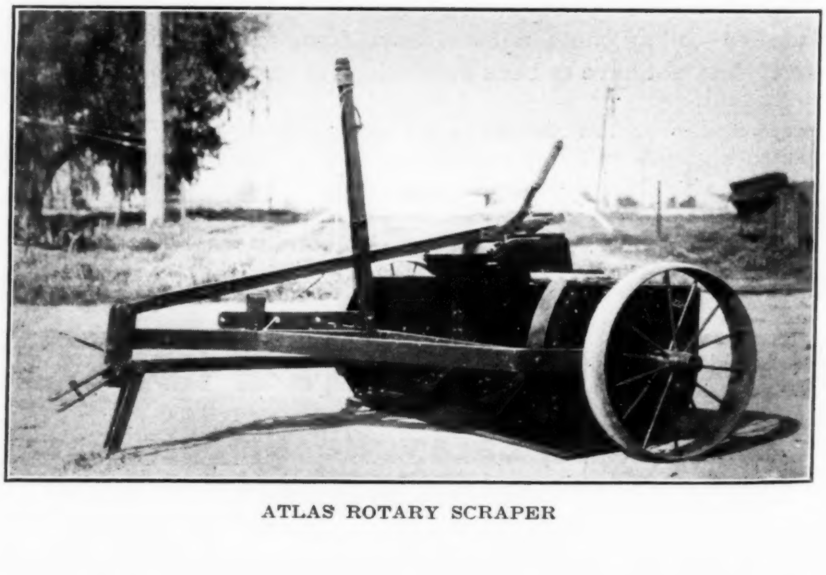
Longer life to the mixer and saving of wear on tires, due to the new spring mounted construction, are emphasized by



JAEGER SPEED QUEEN MIXER

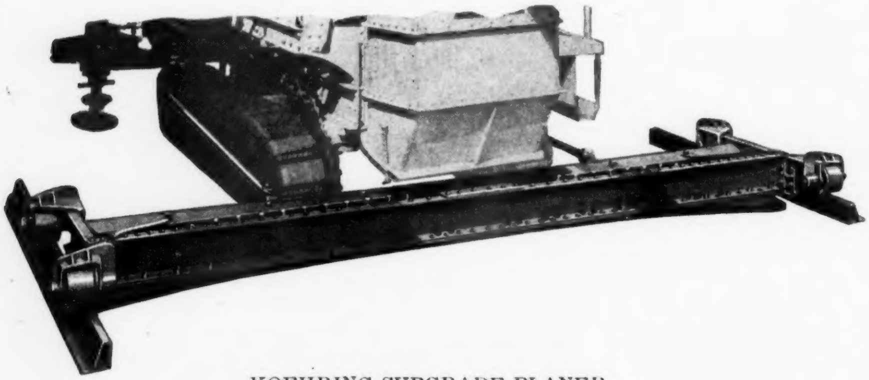
the maker. Being built of steel the Speed Queen combines extra strength with a saving of one-half ton in weight. Rollers and countershaft are ball bearing; the steel disc wheels are roller bearing.

Standard equipment of this model includes automatic skip shaker, accurate measure water tank, 2 cylinder Le Roi engine. The mixer is also built in the low charge type.


ATLAS ROTARY SCRAPER

Koehring Subgrade Planers for Concrete Paving

The Koehring Company, Milwaukee, Wisconsin, manufactures a complete line of subgrade planers. During the past few years, these have become a practical necessity to the paving contractor to prevent hidden losses caused by incorrect preparation of the subgrade. A cut of an inch or even half an inch in depth in excess of the specifications when preparing the subgrade—requiring that much more concrete for which the contractor is not paid—very quickly mounts up into thousands of dollars.



KOEHRING SUBGRADE PLANER

The Koehring subgrade planers are designed for any standard concrete paving, whether laid half width or full width, whether with a center joint or without. Models and sizes include the full width planer with center joint for 16, 18, 20, 22, and 24-foot wide pavements; the full width continuous planer (without center joint) for 16, 18, 20, 22, 24 and 27-foot pavements; the half width planer for 8, 9 and 10-foot width pavement sections; and the 27-foot planer with two joints.

Performing the functions of a grade template, the planer works to best advantage in medium and light soil. In the latter the scarifier teeth will grade to a depth of two inches satisfactorily. It will not operate in old macadam road beds, in hard, packed clay or in imbedded rock.

This machine is attached by two drawbars which fasten to the front axle of the paver with special hub caps. As the paver moves up, the planer follows close in the rear, being just under the loading position of the bucket.

A copy of the new Koehring folder on subgrade planers will be furnished upon request to the main office at Milwaukee or any Koehring representative.

A New Portable Tool Box

Littleford Bros. of Cincinnati, Ohio, have recently placed on the market a tool box mounted on a two wheel trailer. This unit should be a very convenient one for contractors and road construction and repair gangs, or wherever tools are to be transported from place to place and where safe storage overnight is necessary.

The box is 45 inches wide, 8 feet long, 20 inches high at the sides and 25 inches high at the center. A large shelf running through the center the full length of the box provides a convenient place for small tools and equipment. Both covers are hinged and equipped for padlocking.

Box is mounted on the Littleford standard 2½-ton trailer chassis, which is built for high speed traveling. Wheels have 32 in. by 5 in. solid rubber tires and ride on Timken roller bearings. Chassis has semi-elliptical springs and is provided with front and rear drop legs for holding box in horizontal position when stationary.

LITTLEFORD PORTABLE TOOL BOX

Anyone interested in a unit such as this can get full details by writing to Littleford Bros., Cincinnati, Ohio.

Blair Hydraulic Bulldozer

The W. M. Blair Mfg. Co., Chicago, Ill., manufactures the Blair hydraulic bulldozer, which is mounted on a 10-20 McCormick-Deering tractor equipped with traction crawlers. This bulldozer has an exceptionally heavy blade, 84 by 40 inches, heavily braced and reinforced.

The bulldozer is attached to the tractor very simply by means of conveniently located cap screws connecting the guide frame and cylinder assembly with the front of the crawler bolster casting. No holes need to be drilled. The booms of the bulldozer blade are mounted on castings which in turn are attached to the main frame of the crawler. Thus all, the thrust of the blade is taken directly on the crawler frame.

The hydraulic pump is driven off the rear power take-off of the tractor and this pump is controlled entirely by means of a hand control lever conveniently located near the driver's hand. One position of this lever raises the blade. The next position holds the blade at any point, and the third position lowers the blade. Thus the operator has complete and easy control over the fine adjustment of his blade by means of moving the little hand lever a few inches one way or the other.

The accompanying illustration shows one of these machines at work on a job in Milwaukee, where back-filling was done at the rate of nearly 100 yards per hour.

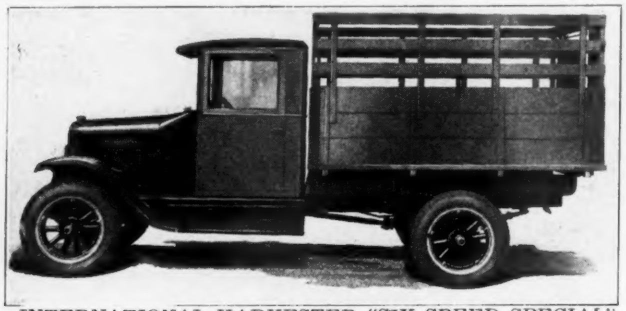
BLAIR HYDRAULIC BULLDOZER

New International Harvester "Six-Speed Special"

The International Harvester Co., Chicago, Ill., has recently brought out a six speed truck designed for satisfactory operation under all conditions—where the going is hard and rough, and where speed is necessary.

The new speed truck, a one-ton unit, is known as the "Six-Speed Special." The truck derives its name from the fact that there are six forward and two reverse speeds. The transmission has three speeds forward and one reverse. A two-speed spiral bevel rear axle of the new

type provides two axle reductions for each transmission speed. There are thus two ranges of speed, one an extra low range ordinarily found only in some of the big heavy-duty trucks. The low range, with its three speeds, is for rough roads, mud, fields, hills, wherever the going is tough.



INTERNATIONAL HARVESTER "SIX SPEED SPECIAL"

The high range, with its three speeds, is for fast hauling where the roads are good.

INDUSTRIAL NOTES

Sullivan Machinery Co., Chicago, Ill., have just published "The Romance of the Diamond Drill."

The Durand Steel Locker Co., and the Lyon Metallic Mfg. Co., have consolidated to form Lyon Metal Products, Inc., of Aurora, Ill., which is stated to be the largest organization devoted to the manufacture of steel lockers, shelving, general steel storage equipment and similar products.

The Northern Engineering Works of Detroit, maker of cranes and hoists, recently appointed The Interstate Supply Co., Commercial Trust Bldg., Philadelphia, as direct factory representative for the Philadelphia district, W. H. Beyer of the latter company personally assuming charge of the account.

New appointments by the Universal Portland Cement Co. have been announced by F. L. Stone, General Sales Manager, as follows: A. C. Cronkrite, assistant general sales manager; Edward Quebbeman, western sales manager; W. L. Greenly, division sales manager for Chicago; Harry A. Craig, division sales manager for Illinois and Missouri; Earle D. McKay, division sales manager at Duluth.

Stone & Webster Engineering Corporation has been formed with a capitalization of $9,500,000 and has taken over from Stone & Webster, Inc., its construction and engineering business and its interest in Ulen & Company. It has also acquired from The North American Company its engineering and construction company known as McClellan & Junkersfeld, Inc. G. O. Muhlfeld is president of the new company.

The Smith Trailer Corporation of Syracuse, New York, has purchased the tracings, blue prints, patterns and templates for the Watson Bottom Dump Tractor Wagon formerly manufactured by the Rex-Watson Corporation of Canastota, New York, and will continue the sale and manufacture of like wagons, to be known as the Smith Trailers. Harold P. Bentley, production manager, formerly connected with the Watson Corporation, will be in charge of production, and R. Shaw Goldthwait, formerly with the Watson Corporation as sales manager, will direct the sales in the new corporation.

New York City has ordered 15 American-LaFrance Type 17-6 17-foot aerial trucks and 6 American-LaFrance special 700-gallon pumping engines. This order brings the total of American-LaFrance apparatus in New York to more than 320 pieces. Boston has ordered 6 Type 17-6 85-foot aerial trucks, one 750-gallon pump and hose car and 6 Type 75 Triple Combination cars. Boston will now have more than 155 pieces of American-LaFrance apparatus.

Heil Co., Milwaukee, Wisc., has appointed Stiles-Murray, Inc., Des Moines, and the Omaha Standard Body Co., Council Bluffs, Ia., as distributors.

Howard C. Bailey, advertising manager of Mack Trucks, Inc., died July 24.

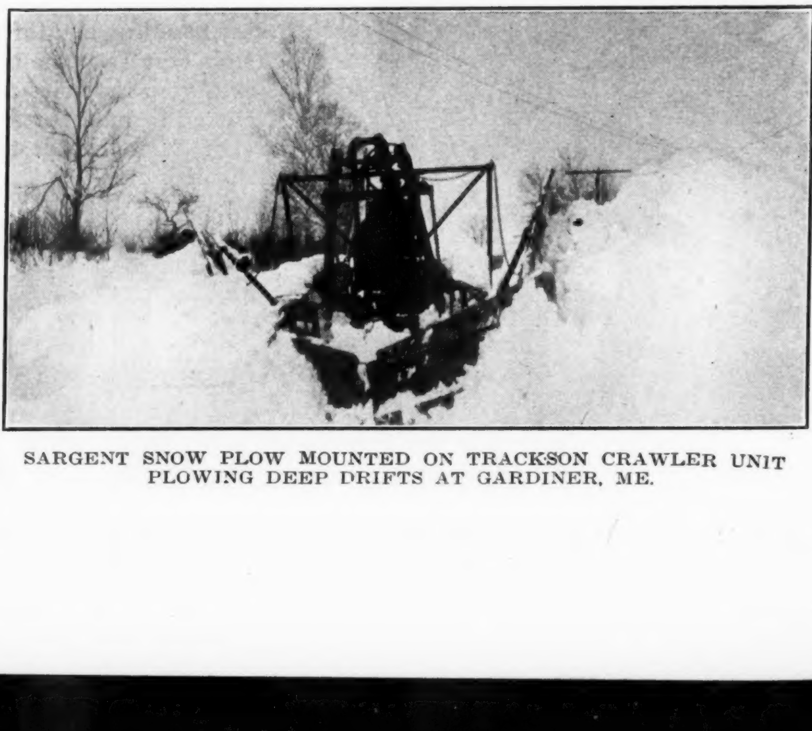
Sullivan Machinery Co., Chicago, Ill., has recently appointed distributors as follows: New York City, N. Y., United Hoisting Co., Inc., 136th Street and Locust ave.; Salt Lake City, Utah, Utah Eastern Iron & Metal Co.; Sacramento, Calif., Standard Equipment & Supply Co.

The Sargent snow plows, snow loaders and other equipment heretofore manufactured by the Union Iron Works, Bangor, Me., are now being produced by the Maine Steel Products Co., South Portland, Me. This company, recently organized, is a merger of the Union Iron Works and the Marine Hardware Equipment Co. It is headed by George C. Soule; Don Sargent, designer of Sargent snow removal equipment, will direct sales. In order to accommodate the new business, a larger wing is being added to the plant.

The Truck Equipment Corporation has been merged with the Municipal Supply Co., South Bend, Ind. D. O. Paulson is president of the Municipal Supply Co., A. C. Rerich, vice-president, and C. F. Greenburg, secretary.

The ratio of the operations to the capacity of the American portland cement industry during the month of July was 87.0 per cent, according to the Bureau of Mines of the Department of Commerce. During the month 17,431,000 barrels were produced, 19,898,000 barrels were shipped, and there were in stocks on hand at the end of the month 22,571,000 barrels. Production in July, 1928 was 0.4 per cent more, and shipments 4.8 per cent more than in July, 1927. Stocks at the mills were 16.4 per cent higher than a year ago.

Paul A. Ivy has been elected vice-president of the National Cast Iron Pipe Company. Controlling interest in this company recently was purchased by James B. Clow & Sons of Chicago. A. P. Finch, works manager, has been appointed general manager; W. H. Saunders has been appointed assistant manager and A. M. Ford, chief engineer. Mr. Finch has been with the company since its organization and is regarded as one of the best pipe foundry operators in the country. Mr. Ford was designing engineer for the original National plant and has been with the company ever since. Mr. Saunders has been Western Sales Manager of the company at Kansas City, Missouri. E. E. Linthicum, who originally organized the company fifteen years ago, will continue as its president. Mr. Linthicum and Mr. Ivy were associated together in the early days of the American Cast Iron Pipe Company. Mr. Linthicum was one of the organizers of that company, built the plant and was its general manager for several years.



SARGENT SNOW PLOW MOUNTED ON TRACKSON CRAWLER UNIT PLOWING DEEP DRIFTS AT GARDINER, ME.